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EDITORIAL NOTES

RINGED BIRDS.

Attention has recently been drawn afresh to the work of the Bird Research Stations on the Island of Heligoland and at Rossitten in Germany by the receipt of a circular despatch on the subject from the Secretary of State for the Colonies. An important feature of the work of the two stations for a number of years has been the ringing of migrant birds that are trapped and released again to continue their journeys. A large proportion of the birds find their way to Africa; and there, owing to the sparse human population and the small proportion of literates among them, the chances of recovery of marked birds and the return of the rings to Germany are enormously diminished. This is a handicap with which any bird-ringing station in Europe has to contend; the workers on similar lines of research in Canada and the northern part of the United States of America are far more happily situated in this respect, and their proportion of recoveries from the broad belt of civilized territory to the south of them has been relatively high.

It is impossible to over-estimate the importance of the information derived from bird ringing in providing a sound basis for a knowledge of many aspects of bird life. Only when the means exist for the particular individual to be identified can the activities and life-history of single birds be followed up. Such knowledge underlies all the problems of bird population, its density, its fluctuations, its economic repercussions, and its maintenance by protection or regulation on a scientific basis. It has, for example, been shown, by the trapping and retrapping of ringed birds that the well-known propensity of birds to return year after year to nest in the same garden or under the same eave has its counterpart in a

fixity of winter resort. In America individual birds far south of their breeding grounds have been taken in as many as six successive winters in the same trap. Thus ultimately it may be possible to say, for example, in what district of Africa the nightingale population of a particular English county tends to spend its non-breeding season, and, moreover, what countries it traverses to get there. As has been shown by ringing, it by no means follows that the route is a direct one. The Whitethroats of Western Europe do not cross the Western Mediterranean to reach Africa, but travel south-eastwards right across Europe. White Storks from Central Germany cross by way of the Bosphorus, travel down through Palestine, cross the Gulf of Suez on an east-to-west line, and only turn south and fan out over the African continent after they have struck the Nile north of Aswan; on the other hand, storks nesting in Holland pass by way of Gibraltar.

The rings used by the German stations of necessity contain as a rule only the minimum inscriptions — "Vogelwarte Helgoland" or "Vogelwarte Rossitten"— which, with the addition of "Germany", are sufficient postal addresses. Anyone fortunate enough to come into possession of a bird carrying a ring, or even the ring alone, is earnestly requested to forward the ring to the station from which it emanated, together with a report giving the date and place of its capture, and of any other particulars. All such reports will be gratefully acknowledged to the senders, who will also be furnished, if they so desire, with information regarding the particular bird in question and the work of the stations generally.

Well over one hundred different forms of birds breeding in Europe and Asia have been recorded as visiting the British East African territories in winter, some of them in such numbers as to form between October and March a most important, if not the predominant, element in the avifauna of particular localities. A convenient summary of available information on the subject is contained in Dr. V. G. L. Van Someren's "Catalogue of the European and Asiatic Migrants to Kenya and Uganda with Brief Outline of the Subject of Migration of Birds" in the *Journal of the East Africa and Uganda Natural History Society*, Special Supplement No. 4 (October, 1931).

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Water Control in the Arusha and Moshi Districts.

The control of the water supplies available for irrigation from the mountains Kilimanjaro and Meru has been a fruitful source of dispute and strife probably from times immemorial. The increasing development of agriculture, both European and native, has augmented the difficulties of administration with which the present water boards have been involved. Recognizing the need of a fundamental inquiry into the subject, the Tanganyika Government appointed two officers of special competence, Dr. E. O. Teale, Director of Geological Survey, and Mr. C. Gillman, Chief Engineer of Railways and a distinguished geographer, to investigate the proper control of water and the reorganization of water boards, and to submit a concise statement of the problem and advice as to the proper means of tackling it.

The report of the inquiry, issued by the Government Printer, Dar es Salaam, is a document of social, agricultural and geographical interest. The system of irrigation practised, by furrows led out from the mountain streams, and largely applied to lands which themselves lie on the mountain slopes, is very different in

character from the conventional type. The natives, especially the Wachagga, developed unaided remarkably skilful methods of handling water, and controlled its use by recognized laws and customs. On this basis they established a relatively high standard of agriculture and social life.

The European settlers, most of whom are coffee planters, with no tradition to guide them have had to experiment with the use of water, and there still remains wide diversity of opinion and of practice. More systematic study of methods of application would in itself undoubtedly lead to considerable economy of water.

On the subject of the origin of the water from these mountains, the authors challenge the popular notion that it is derived, in the case of Kilimanjaro, from the melting of the conspicuous ice-cap with which the dome of Kibo is crowned. Most of the wastage from the ice and snow passes directly into the atmosphere as vapour; the bulk of the water which feeds the springs and rivers is collected in the forest zone. The dangers of deforestation and the need for reafforestation are strongly emphasized as lying at the root of the whole matter. The special liability of irrigated slopes to soil erosion is the subject of serious warning. In this connection, the native methods of growing Eleusine have long been denounced by the local agricultural officers, but interference is resented in much the same spirit as alleged attempts to "rob the working man of his beer" in England. The authors advise that benevolent but firm compulsion should be applied to supplement education and persuasion.

Various criticisms of existing practice are made and suggestions leading to improvement given. The main recommendation is that an immediate hydro-topographical survey, supplemented by a regional survey, should be undertaken, in order to obtain the many data without which it is impossible for the water boards to function efficiently. A new and much more elaborate water law is advised, and the suggestion made that it should follow the recommendations made in 1925 to the Government of Kenya by the Director of South African Irrigation.

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REPORT OF THE TANGANYIKA DEPARTMENT OF AGRICULTURE, 1934.

The Annual Report of the Department of Agriculture, Tanganyika Territory, 1934 (Government Printer, Dar es Salaam; Sh. 4), has recently been issued, and throughout its 141 pages affords evidence of a many-sided and exceedingly active organization. The Director's review of the year, while recording local disasters due to drought and general anxiety due to the wide distribution of locusts, shows that the effects of the former were balanced by record yields elsewhere, and demonstrates the soundness of an agricultural policy based on an increasing diversity of crops and an equal diversity of agriculturally developed areas, not all of which are likely to prosper or to fail together. Sisal is approaching an annual value f.o.b. of a million pounds, coffee almost half a million, cotton and gold (which is included as representing the consumption of agricultural supplies and labour) £300,000 each and rapidly increasing, while several products in the second rank (hides and skins, rice and grains, groundnuts and tobacco) have export values of £50,000 to £150,000, supported by others (beeswax, copra, and sesame) which may approach the lower of these figures.

The action taken to increase native production is held to be justified by the greater faith in the stability of the Territory which has resulted from its success.

To maintain the standard reached control of marketing is regarded as essential. The honest trader has to suffer restraint because of the misdeeds of others not like-minded. An interesting section reviews the progress which is being made towards the better distribution of the native population by planned development, hand in hand with agricultural education. The primary issues are recognized to be the development of communal and individual water supplies, both for consumption and irrigation, the food store of harvested grain, stock feed, and ground provisions, the use of manure and compost, the making of roads, and the control of erosion. Following these come improvement of seed, grading, and the realization of the crop. In the larger issues the necessity of orderly progress, without haste, is emphasized.

The notes on the chief export crops, the divisional and experiment station reports, and those of the technical officers are full of interesting matter, to some of which further reference will be made in later issues of this Journal.

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OMISSIONS.

In the first number of this Journal, article on *Overstocking in Kenya*, p. 19, col. 2, line 16, the statement made should be qualified by adding the word "some" before "European farms".

In the same number, pp. 14-15, article on *Measures Against Soil Erosion*, the photographs reproduced were taken by Mr. J. G. M. King, District Agricultural Officer, who was also responsible for the work depicted.

Research Notes

STUDIES IN TROPICAL SOILS—INCREASE OF ACIDITY WITH DEPTH, *by* H. C. Doyne. *Jour. Agric. Sci.* 25, 192, 1935.

The author records Nigerian soil profiles showing acidity increasing with depth, and refers briefly to the agricultural importance of this peculiar feature of many tropical soils. Two types of acidity profile are shown; one in which acidity increases abruptly in the immediate subsoil and then shows no regular increase or decrease, the other in which acidity increases gradually to the middle subsoil and then decreases to the base of the profile. The first is tentatively explained by the removal of bases from the subsoil by plant roots and subsequent deposition on the surface in plant refuse and release on rapid microbiological destruction of organic matter; the second by the denudation of the profile, under a periodic climate, of its bases in two directions—downwards by leaching, upwards by evaporation—resulting in a desaturated middle subsoil.

Both types occur in East Africa, the first somewhat locally; while there are instances of certain types of natural vegetation having the opposite effect and increasing topsoil acidity. The second type seems fundamentally the more interesting, and is characteristic of a large number of mature red soils. In Nyasaland this is regarded as the normal distribution of profile acidity. The explanation offered seems applicable to some, but by no means all, East African examples of this type. In view of recent work on the coffee root system (of which the author is apparently unaware) the recognition and exploration of this property of a group of tropical soils becomes of practical importance. W.E.C.

STUDIES IN PHANEROGAMIC PARASITISM WITH PARTICULAR REFERENCE TO *STRIGA LUTEA* Lour. A. R. Saunders, *Sci. Bull. No.* 128, *Dept. Agric., Union of South Africa.*

The witchweed, *Striga lutea*, parasitic on grasses, especially maize and sorghums, is surpassed only by the stalk-borer in reducing the yield of these crops in South Africa, and more than equals in this respect all other pests and diseases combined.

The bulletin under notice records comprehensive studies under three heads —1, The economic importance, distribution, life-history, and parasitism of *Striga lutea*; 2, Experiments on the control of the parasite in the field; 3, The breeding of resistant host varieties.

The first section describes studies of the parasitic relationship, of which the experiments demonstrating the existence of an excretion from the roots of the host, on which germination of the seeds of the parasite depends, are of fundamental importance. Apart from the necessity of this stimulus, seeds in the soil undergo progressive maturation, so that not more than five per cent will germinate when fresh, and a maximum rate is only reached after eighteen months. The seed remains viable for many years; an instance is given of undiminished infestation after fourteen years of non-susceptible crops.

The quantity of witchweed which develops above ground is not a measure of the degree of infestation. As many as 500 seedlings may attach themselves to one maize plant, of which only a small proportion survive the intensive competition. This fact explains the disparity between severe damage to the crop and the visible number of parasites, in that the heavier the infestation the smaller the proportion of plants which emerge.

The pest can be controlled by persistent and careful weeding, which prevents the production of further supplies of seed, and this result can be greatly accelerated by the use of trap crops, which are removed before the parasite has time to seed. Of these the most efficient are the sorghums, and especially Sudan grass, of which two crops can be grown in a year and used as hay or fodder.

The resistant character of the seed-coat of witchweed makes chemical treatment of the soil impracticable. After germination the seedlings are of course susceptible, but it will be difficult to find a method of poisoning which does not equally affect the crop. Surface spraying with chlorates is effective, but is open to the same objection, in addition to that of expense.

Crop rotation, for reasons already given, is ineffective, and fertilizers, though they increase yields, have no effect on infestation. Close spacing is shown by experiment to be the reverse of beneficial. Of the agronomic methods tested the only one which had promising effects was the listing system, in which the maize is planted between banks, which are afterwards divided so that the soil covers and destroys the weeds in the furrows.

Perhaps the most hopeful discovery recorded is that certain native strains of kaffir-corn, while they stimulate the seeds of witchweed to germinate, possess a high degree of resistance to parasitism. This opens up the possibility of clearing the soil in the course of a few years from witchweed, while at the same time obtaining crops little reduced by its presence. While some differences in resistance have been observed in maize, no variety has yet been found to possess this quality to a useful degree.

W.N.

VERNALIZATION.

This term, a latinization of the Russian *Jarowizacii*, is applied to a method of treating seed so that it completes its development more rapidly than normally when sown in the field. This acceleration of development is often of considerable practical advantage, more especially in areas where only a short period of the year is suitable for growth. The method originated in Soviet Russia, where, according to Maximov, one million hectares were sown with vernalized seed in 1934.

Lyssenko, who developed the method, pictures the development of the plant from the seed to the flowering stage as a chain of developmental states, all of which are obligatory; each may require a different combination of external factors for its initiation. Vernalization aims at enabling the plant to pass through the early stages of development rapidly, while in the form of a seed.

Plants have for a long time been divided into three main groups, according to the length of day necessary before flowering. "Long-day" plants, such as oats or barley, normally flower in the long days of summer; others, chrysanthemums for example, will never flower until the length of day is reduced below a certain limit, while length of day has little effect on the third group. The technique of vernalizing the first group is now well known, and has been successfully used in many parts of the world. Water is added to the seed in sufficient quantity just to induce germination. The temperature is then reduced to about 3° C. and is held between 0° and 5° C. for 12 to 15 days. The seeds are then planted, or may be dried for future use, provided that they do not remain in the dry condition for any considerable period. Such seed will reach the flowering stage much earlier than usual. As an example of the practical advantage of such treatment, the growth of wheat in the Ukraine may be cited. The best local variety is taken as giving a yield of 100 per cent. An imported wheat gave only 8 per cent, but the same variety, when vernalized, yielded 141 per cent.

Recent work in England has explained much of the significance of the Russian discovery, and has shown that the temperature at which germination takes place has an effect on the length of day under which the initiation of flowers occurs.

The Russian literature also gives directions for the vernalization of "short-day" plants, such as maize, millet, or sorghum. Germination in total darkness and at high temperatures for 10 to 15 days is necessary. The plants will then flower under long-day conditions, or even under continuous illumination. Trials of vernalized maize and rice have been carried out in Ceylon; no advantage for the treatment was shown for maize, while with rice the difference, though significant, was but slight.

It does not appear probable that vernalization will have much effect on tropical agriculture, although it is quite possible that it will enable tropical crops to be grown successfully at higher latitudes. When once the condition "ripeness to flower" has been attained, tropical crops appear to flower a constant time afterwards, irrespective of the length of day. And since this condition is produced by short days, the normal tropical state of affairs, there appears to be no reason why vernalization should give any marked acceleration of the normal development.

F.J.N.

THE EFFECT OF ENVIRONMENTAL CONDITIONS UPON PYRETHRUM, Martin and Tattersfield. *Ann. Appl. Biol.* 21, No. 4.

The first section presents evidence that variation in soil fertility, within wide limits, does not affect the growth or flowering of pyrethrum. Plants were grown in pots in soil of the following analysis: —

C	1.85 %
N	0.17
K as K_2O	0.37
P as P_2O_5	0.14
K (citric acid soluble)	0.012
P (citric acid soluble)	0.012

This soil is definitely of lower fertility than most African soils. Manures, both artificial and organic, were applied in various combinations, but, after the first year, there was no significant increase in the yields of flowers obtained. Neither was their pyrethrin content affected. It appears that to apply manures to pyrethrum will rarely be necessary under African conditions.

The second section deals with the effect of climatic conditions on the flowering of pyrethrum. The inter-relationships of temperature and light are marked. Plants grown at a high summer temperature give fewer, lighter, and less toxic flowers. The flowering period is also considerably extended. Shading produces a similar effect, at both high and low summer temperatures.

It is clearly shown that, under European conditions, a period of winter dormancy is necessary for successful flowering in the following summer. This dormancy can be induced by low temperatures. But the temperatures necessary, the length of the period of application of those temperatures, and the possible effect of other conditions in modifying the temperature effect are as yet unknown.

Lacking this knowledge, it is impossible to apply the findings of this paper to local conditions in any detail. That pyrethrum will grow well at high altitudes is known, and although it has a lengthy flowering period its toxicity is not reduced. The high light intensity normally experienced in East Africa might be expected to maintain the pyrethrin content at a high level, while the temperatures at altitudes over 6,000 feet (possibly modified by other factors) appear to be sufficient to induce flowering. The failure of this plant to produce flowers at lower altitudes is certainly due to the higher temperatures there met with. F.J.N.

Development of the Mlingano Sisal Experimental Station

By G. W. Lock, *N.D.A., N.D.D., District Agricultural Officer (Sisal), Tanganyika Terriory.*

Introduction.

Although it is only a comparatively short time since the scheme materialized, the establishment of a sisal experimental station in Tanganyika has been contemplated for some years past. The need for such a station has been long recognized, and it is satisfactory to record that means have now been found for conducting investigational work on sisal. The Department of Agriculture was enabled, through the aid of the sisal industry represented by the Sisal Cess Board, and the Colonial Development Fund, to secure Mlingano Estate in late 1934, and East African sisal planters will doubtless be interested to know the progress which has been made so far in the development of this property as the future sisal experimental station.

Situation.

In more respects than one, Mlingano Estate is eminently suitable for the purpose for which it was acquired. It is situated on the northern side of the main Tanga-Korogwe road by the Kibaranga turning, 20 miles distant from the coast. Accessibility is therefore one advantage it possesses, apart from the fact that it is also placed near the heart of the chief sisal-producing areas of the Tanga Province. The railway passes the estate, affording an adequate daily service of trains which halt on the boundary for passengers, while Ngomeni Station, reached by an all-weather road, is only 2½ miles away. The Amani Research Station is little more than one hour's journey by car from Mlingano. People connected with the sisal industry who are travelling on ships calling at Tanga may often have ample time to visit the Experiment Station during their stay in port.

Description.

The property is a rectangular block of land, 440 hectares (1,087 acres) in size, adjacent to Geiglitz Estate on the eastern side and bounded on the west by a long open grassy valley and Muhesa Estate. The site has an altitude of about 300 feet above sea level. The general soil type is a rich, deep, bright red sandy loam which has been formed in situ from gneiss. This soil has a particularly uniform nature, more especially in the southern section of the estate, where the topography is level or composed of gentle slopes. The annual rainfall is in the region of 1,100 mm., which is well-nigh typical of many sisal-growing localities in the district. All these features are important ones which commend the estate for an agricultural experiment station. Towards the north and west small depressions and valleys give the land a more broken character, less suited for experiments.

Progress of Development.

Development work was inaugurated immediately after possession was obtained. At that time practically the entire estate was covered with a dense forest of derelict Ceara rubber (*Manihot Glaziovii*) and undergrowth, which had to be explored for the best experimental areas before clearing could be started in earnest. The whole of the undergrowth in the southern half was eventually removed to permit closer examination. As a result, large level tracts, fairly free from ant-hills and extending to 50 hectares, were revealed, so clearing was accordingly commenced in this quarter towards the

end of December; included was a part which was converted from standing rubber to planted *Agave amaniensis* within a space of two months. Thenceforward, felling has progressed steadily as the labour supply admitted, and to-day more than 126 hectares (310 acres) have been opened up. It is proposed to remove all the rubber in due course.

The details of present clearing work consist of felling the rubber below ground level, light stumping, together with stacking and burning where permissible. Areas not yet touched will be rough felled, since they will not be required for some years ahead, and it is cheaper to allow the cut trunks and stumps to rot. Standard wages are paid to labour, and the complete costs of preparing the land in good order for planting work out to the reasonable figure of Sh. 76 per hectare (Sh. 30 per acre).

Planting Work.

One of the first tasks was to prepare a nursery. A level, uniform piece of land, just over one hectare, was cleared without burning, given a deep cultivation, and planted with 88,000 bulbils, kindly supplied by various estates. The bulbils were selected and graded before planting out at a spacing of 50 x 25 cm., as the intention is to provide evenly developed planting material for the main experiments to be laid down next year. At the beginning of March, 17,678 *amaniensis* suckers from Amani were planted out 2½ x 1½ m. (8.02 x 4.9 ft.), or at the rate of 2,666 per hectare, leaving room for access roads. Once adequate rains had fallen, the plants struck satisfactorily, and the plantation now presents an attractive sight of bright blue rows against a background of red soil. Besides the multiplication of this promising new Agave by suckers and bulbils, this area allows for testing *amaniensis* on a commercial scale in the plains.

Buildings.

When the felling was sufficiently advanced, sites were chosen for the future buildings. These have a northerly aspect overlooking the Mkulumuzi and Sigi valleys, with a pleasant prospect of the Eastern Usambara Mountains beyond. The buildings will comprise two residences and an office block in between. Work on the houses has already reached a forward stage, and after completion the office and laboratory building will be erected. Electric light and power is available from the new power line which passes through the estate.

At the time of taking over there were no buildings existing on the estate, which necessitated the erection of temporary quarters for Europeans, native staff, stores, and a labour camp. Water is not abundant, and arrangements were made for surface water collection which will later be of a more permanent character.

Laying Out Grounds.

Approach and estate roads have been made and the grounds developed as far as practicable. Near the buildings, over two hectares, intersected with wide paths, have been prepared for a collection of Agaves. So far it contains a varying number of each of twenty-one of the more important species of Agaves, supplied from Amani and elsewhere, as well as *Furcraea gigantea*, Ramie (*B. utilis* and *B. nivea*), pineapples, and cover crops. *Calapogonium mucunoides* has been used mostly as a cover crop. The collection will serve as a living museum of Agaves, which it is hoped to make more representative as opportunities occur for adding other kinds. Another purpose of major importance is to provide poling Agaves for the use of the Geneticist in his breeding work. To attain this a succession of annual plantings will be required.

Experimental Areas.

The rubber and bush on the main experimental areas has now been reduced to ground level for destruction by white ants, but the greater part will soon be removed by light railway. Burning cannot be resorted to in this instance on account of the disturbing effect it has upon soil uniformity, to which a primary regard must be paid in field experimental work. These sections are close to the buildings.

Other Crops.

A large valley in front of the houses will be used for citrus and other nurseries since the soil is somewhat richer, due to soil wash in the past, and, in addition, the site is well sheltered. Approximately 200 seedling trees of *Mundulea suberosa* Benth. have been planted out on one side for trial in co-operation with the Amani Research Station in its work of searching for local sources of raw material for insecticides. This plant likes a warm dry climate.

Estate Trials.

The work of the Station to date has not been confined solely to development. Spacing and manurial experiments have been started in the nursery, whilst on outside estates two manurial trials have been put down, one being in connection with "banding" disease. Other investigations concern the sisal weevil, in collaboration with the Assistant Entomologist, the killing of tree stumps, composting sisal waste, and a uniformity trial. Meteorological readings, including sunshine records, begun early in the year, are made daily.

After seven months' preparation, the Sisal Experimental Station is gradually taking shape, and it is confidently anticipated that most of the preliminary work will be accomplished before the end of the year. By that time the station will be almost ready and its activities largely devoted to the experimental programme which it is proposed to undertake.

The Length of Sisal Fibres with particular reference to Grading Problems

By F. J. NUTMAN, *M.Sc., D.I.C., Plant Physiologist, East African Agricultural Research Station, Amani.*

The producers of sisal fibre are now taking great interest in the grading of their product. The arguments in favour of grading are familiar to everybody, and I need not recapitulate them here. My purpose is to summarize some of the data which have been accumulating at Amani on the variation in length of sisal fibre; in the light of this knowledge to discuss whether grading is practicable, and, if so, to suggest the most suitable characteristic of the fibre to embody in a grade definition.

Any grading which has been carried out up to the present has been on a length basis, and correctly so. Although other characteristics of the fibre may be of importance, and may vary from area to area and from time to time, it does not appear to be practicable to grade for such qualities as, say, fineness of fibre, or for intrinsic fibre strength. At present any move towards the revision of sisal grades can only take the form of an increase in the accuracy of grade definitions or an improvement in the uniformity of the material falling in any one grade.

Various methods are in use in the attempt to grade sisal. It is usual for leaf selection to be carried out on the feeding table of the decorticator, all damaged leaves or those below a certain length being discarded, and eventually decorticated for low-grade material. This is supplemented on some estates by leaf selection in the field, whereby all short leaves are bundled separately or are left to rot. These methods are troublesome, need careful and expensive white supervision, and both are inefficient, especially when an area with rather short leaf is being cut. The following figures refer to the leaf passing into the decorticator on a first-class East African estate. They are based on random samples of the leaves taken over one afternoon.

TABLE I

PERCENTAGE OF LEAVES SHORTER THAN THE FIGURE (in cm.) AT THE HEAD OF THE COLUMN

CENTIMETRES						
50	60	70	80	90	100	110
0	2	16	42	77	96	100

Average length of leaf—82 cm.

Leaf which was shorter than usual was admittedly being cut on that particular day. But the point which I want to make is that, although grading was being carried out, more than 77 per cent of the already graded leaf was shorter than 3 feet. On another day, when very long leaf was being cut, averaging as much as 103 cm. and running up to 150 cm., 21 per cent of the leaves were shorter than 3 feet. It is clearly not possible to grade efficiently by leaf selection, whether mechanical or otherwise. The mere bulk of the short leaves would create a serious problem in any factory.

In the brushing shed, selection by hank length is theoretically carried out. Apart from the proved inefficiency of such selection, the estimation of the length of the hank slows up the rhythm of production or necessitates the employment of extra labour.

The foregoing methods were designed to separate the fibre into No. 1 and No. 2 grades. These were understood, though rarely defined, to be based on the length of a *hank* of fibre; in my opinion, a perfectly sound criterion, for reasons which will appear later. A certain body of opinion thinks otherwise, and new grading definitions are being proposed.

By a natural mental process, the emphasis implicitly placed on the length of the hank has become transferred to its individual constituents; that is, to the length of the individual fibres. This is a completely different thing. Let us consider the relationship between the length of the hank and the length of the fibres which compose it.

The leaf of the sisal plant contains approximately 1,000 fibres, varying in length from a few inches to the full length of the leaf. These fibres, less the waste in decortication, should be considered as one hank. The relationship between the length of the leaf and the number of fibres below any given *length* is a complicated one, and is not yet fully understood. That between the leaf length and the percentage *weight* of fibres shorter than a given length is comparatively simple, and will serve our purpose. The following data were obtained from sisal leaves decorticated singly by raspador. Waste amounted to 19 per cent on the total fibre, and the percentages refer to the actual fibre extracted, ignoring waste. As the percentage of waste is of the same order as that usual commercially, the figures give an approximation to the composition of the fibre which would normally be obtained from the factory decortication of leaves of the lengths stated.

Where x is the percentage by weight of fibre shorter than g, and where l is the leaf length, then—

$$\log x = \frac{3{\cdot}012g}{l} - 1{\cdot}012$$

This can be tabulated as follows:—

TABLE II

Relationship Between the Leaf Length of Sisal and the Percentage by Weight of Fibres Below the Lengths Appearing at the Head of Each Column (in cm.). 19 per cent Waste, Consisting Mainly of Short Fibres, Neglected.

Length of Leaf	Centimetres									
	40	50	60	70	80	90	100	110	120	130
60	11	31	100							
70	5	14	37	100						
80	3	8	18	42	100					
90	2	5	10	22	46	100				
100	2	3	6	10	25	50	100			
110	1	2	4	8	15	28	53	100		
120	1	2	3	6	10	19	32	56	100	
130	1	1	2	4	6	12	20	34	59	100

It is immediately apparent that, with the length of leaf attainable under estate conditions, the percentage of fibre shorter than a suitable grade length is very considerable, even allowing for the fact that an additional small percentage of the shorter fibres will be lost in the process of brushing.

The following table shows the percentage of sisal fibres shorter than any given length in the finished product of four East African estates. Two are situated in Kenya, and two in Tanganyika Territory. These four sets of figures have been chosen at random from a large number of similar records. The samples were supplied by the estates themselves as "Selected No. 1", and, presumably, represent the high-water mark of commercial sisal.

TABLE III

THE FIGURES REFER TO THE PERCENTAGE NUMBER OF FIBRES SHORTER THAN THE LENGTHS (in cm.) APPEARING AT THE HEAD OF EACH COLUMN.

ESTATE	CENTIMETRES							
	10	20	30	40	50	60	70	80
a ..	0	0·4	0·5	1	3	10	19	31
b ..	0	0·1	1	3	4	7	24	36
c ..	0	0·1	1	4	8	13	24	34
d ..	0·3	1·0	4	9	14	24	34	46

ESTATE	CENTIMETRES						
	90	100	110	120	130	140	150
a ..	44	57	76	92	99	99·8	100
b ..	46	56	64	69	83	87	95
c ..	50	54	62	75	89	98	100
d ..	59	70	84	92	95	99	100

In view of the foregoing data it is at once obvious that it is not possible to grade sisal on the length of the fibre. The fibres present in the leaf vary in length over an extremely wide range, and this variation is not materially reduced by the processes of decortication and brushing. Nor, incidentally, is it known whether a product consisting solely of long fibres would be acceptable to the manufacturer, who has certainly no experience of such material.

All things considered, the old basis of grading on the length of the hank appears best. The grade is defined by a definite and easily measurable quantity; and it appears probable that certain other characteristics of sisal fibre are correlated with the length of the hank. A grade based on this character can be a definite one, and can be conformed to; whereas not a single bale of commercial sisal will ever be produced conforming to a grading definition calling for a reasonable minimum length of fibre.

The main grading problem resolves itself into the ways and means of ensuring that the grade shall contain only hanks of a certain minimum length. It is sufficiently obvious that grading by hand is not very efficient. It is always better to grade mechanically if this can be done. No personal factors are involved, production rhythm is uninterrupted, and a more uniform product is obtained.

It should be kept in mind that the hank of fibre resulting from the decortication of one leaf should be the unit. To estimate the length of a collection of such hanks, as is the present practice, is little use. A bundle of fibre is certainly produced which appears to be a unit, but in reality is not so. And the length of such a bundle bears little relationship to the distribution of the lengths of its constituent fibres. In a hank from a single leaf, on the other hand, we have seen that a definite relationship holds between its maximum length and the lengths of all the shorter fibres.

A mechanical grader has been developed on one East African estate which will grade the fibre during the process of decortication. This ingenious yet simple attachment appears to be infallible. So soon as the distal portion of a leaf is decorticated by the first drum its length is automatically estimated. If shorter than the length for which the machine is set, it travels through the remainder of the decorticator side by side with the fibres from the longer leaves, but emerges from a separate exit. The decorticator thus produces graded fibre, and there is no necessity for further trouble in the brushing shed. The basis of grading is *the maximum length of a hank produced from one leaf*, and that, as we have seen, is the only method practicable at present which is not open to numerous objections.

(*Continued on page 106*)

The Influence of Aquatic Plants on the Conservation of Water

By T. W. KIRKPATRICK, *M.A., East African Agricultural Research Station, Amani.*

Information was recently sought from the East African Agricultural Research Station, Amani, by the manager of a sisal estate, as to whether any aquatic plants could be recommended for growing in ponds and reservoirs, for the purpose of reducing the very considerable loss by evaporation therefrom.

Reference to all the available literature on plant physiology and ecology, as well as to books dealing with irrigation, failed to throw any light on the subject; it could not even be ascertained whether, in general, the loss of water by transpiration from aquatic plants was likely to be greater or less than the loss by evaporation from a water surface uncovered by vegetation.

An inquiry was then addressed to Dr. H. E. Hurst, Director of the Physical Department in the Egyptian Government, who has done a great deal of research on the hydrography and water resources of the Nile Basin. However, the only information he was able to furnish concerned an experiment undertaken in the Sudd region of the Upper Nile with papyrus (*Cyperus Papyrus* L.), about which Dr. Hurst write: "The experiment is therefore not very conclusive, but considering all the information I think we can say that the water loss from papyrus growing in swamp is likely to be greater than from a free water surface."

Seeing therefore that so little seemed to be known about an elementary matter of some importance where conservation of water is a desirable objective, it appeared to be worth while making a few simple experiments.

The water plants used were:—

(1) *Nymphæa capensis* Thunb., a blue water-lily with large leaves, most of which lie flat on the water and present an apparently dry surface.

(2) *Pistia stratiotes* L., or water lettuce, which may (and in the experiments did) completely cover the surface of the water, though, as the majority of the leaves float above the surface, the total leaf-area is much larger than that of the water surface in which it is growing.

(3) *Wolffia Michelii* Schleid, a small floating plant resembling a duck-weed (but differing from the true duck-weeds in having no roots). A thick growth of this plant completely covers the water, and provides an apparently dry surface.

(4) A species of true duck-weed (*Lemna*) was also used on a smaller scale.

The plants were grown in basins having an area of about 1,200 square centimetres, and the loss of water compared with that from an exactly similar basin containing an equal quantity of plain water. (In case there might have been some scarcely measurable difference in the area of the basins, the one used for the control was exchanged at intervals with the others.) The amount of water lost by transpiration and evaporation was determined by weight, a method which permitted measurement to an accuracy equivalent to 10 grams per square metre, or the one-hundredth part of a millimetre in depth.

In the case of (4), the *Lemna*, of which only a small quantity was available, and of some of the experiments with *Wolffia*, comparisons were made in large flat Petri dishes. These could, however, be weighed to 5 milligrams, and the degree of accuracy is comparable to that of the experiments performed in basins.

Two possible objections to these experiments must be made. Firstly, the evaporation of water, or transpiration from plants, in comparatively small basins may not be, and indeed is unlikely to be, the same as that in a pond or reservoir of perhaps an acre or more in extent. Other factors such as exposure to sun and wind being equal, it is probable that there is a proportionately greater loss from a small area. There must, however, be some relation between the two. Secondly, the experiments were made at Amani, where, owing to the higher humidity and lower temperature, evaporation is much lower than in a warmer and drier locality, where problems of water conservation are likely to be of moment. However, it was observed that in nearly all cases the higher the rate of evaporation the greater was the comparative increase of loss from the aquatic plants. It can therefore be reasonably assumed that the difference would be increased in a district where the evaporation was high. Moreover, to some extent, the performance of the experiments under conditions of low evaporation offsets the previous objection.

It is perhaps scarcely justifiable to translate the results from experiments done on such a small scale into terms of gallons of water lost per acre, but if it is desired to get some idea of the enormous wastage from evaporation and transpiration, it may be pointed out that a loss of 100 c.c. per square metre, or the one-tenth part of a millimetre in depth, is equivalent to 89 gallons per acre.

Typical results are given in the following four tables: —

TABLE I

COMPARISON OF THE LOSS OF WATER FROM NYMPHÆA AND FROM A PLAIN WATER SURFACE. (Experiments made during June and July, 1935)

	Average loss per hour in cubic centimetres per square metre		Percentage increase or decrease from *Nymphæa*
	From *Nymphæa*	From Control	
(*a*) During the whole period of 18.vi-13.vii	59	55	+7
(*b*) During periods, totalling 44 hours, mainly sunny, between the hours of 08 and 16	261	223	+17
(*c*) During periods totalling 22 hours, mostly overcast, between the hours of 08 and 16	106	101	+5
(*d*) During the hours of 16 to 08 (ten nights without rainfall) ..	48	49	—2

TABLE II

COMPARISON OF THE LOSS OF WATER FROM PISTIA AND FROM A PLAIN WATER SURFACE. (Experiments made during December, 1934)

	Average loss per hour in cubic centimetres per square metre		Percentage increase or decrease from *Pistia*
	From *Pistia*	From Control	
(*a*) During the period 13.xii to 17.xii ..	95·5	76	+25
(*b*) During mainly sunny periods between the hours of 09 and 16	352	269	+31
(*c*) During the hours of 16 to 09	42	44	—5

TABLE III

COMPARISON OF THE LOSS OF WATER FROM WOLFFIA AND FROM A PLAIN WATER SURFACE.
(Experiments made during July, 1935)

	Average loss per hour in cubic centimetres per square metre		Percentage increase or decrease from *Wolffia*
	From *Wolffia*	From Control	
(*a*) During the period 10.vii to 13.vii ..	86	84	+2
(*b*) During mainly sunny periods, between the hours of 08 and 16	227	204	+11
(*c*) During the hours between 16 and 08 ..	36	42	—14
(*e*)*During the period 23.vii to 2.viii ..	33·7	33·1	+2
(*f*)*During periods totalling 14 hours, mainly sunny ..	52	41	+27
(*g*)*During three nights (17 to 08 hours)	27	28	—4

*These three experiments were made indoors, i.e. in an almost complete calm; the sun, if any, shining through glass; and were done in Petri dishes, as with the *Lemna*.

TABLE IV

COMPARISON OF THE LOSS OF WATER FROM LEMNA AND FROM A PLAIN WATER SURFACE.
(Experiments made during December, 1934)

	Average loss per hour in cubic centimetres per square metre		Percentage increase or decrease from *Lemna*
	From *Lemna*	From Control	
(*a*) Indoors, during the day, in a strong breeze from electric fan	340	360	—6
(*b*) Indoors, during the night, no breeze	37	34	+9
(*c*) Outside, during the day, mainly sunny, considerable wind ..	810	712	+14

These tables call for little comment. In each case the aquatic plant slightly decreases the loss of water during the night, but the loss being then in any case small, this does not compensate for the increased loss by day, which is comparatively greater during sunny periods. As was to be expected, the *Pistia* causes a greater loss than the plants of which the leaves lie flat on the surface, though even these definitely increase the loss.

In this connection attention may be called to a letter in a recent number of *Nature* (Vol. 135, p. 914, June 1, 1935), in which Mr. A. E. Boycott writes: "Last summer (1934) a cement tank in my garden (Radlett, England), with *Potamogeton crispus* and *Lemna*, lost 5 inches of water, while a precisely similar tank a few feet away, which had three good clumps of *Alisma plantago*, lost 19 inches and went dry.

In conclusion, it may be said that the best methods for minimizing the loss of water from ponds and reservoirs would appear to be to keep the water clear of aquatic plants, and if the area is too large to make it practicable to shade the surface from the sun, to erect windbreaks round the edge, or at least on the side of the prevailing wind.

The Length of Sisal Fibres, etc.—

(*Continued from page 103*)

The advantages of such grading are great. No longer need the *shamba* staff worry about the cutting of short leaf, and no longer need the sorting gang on the table be supervised. Leaf of any length can be cut and fed into the decorticator, and all the fibre emerging from the high-grade exit will consist of hanks of a definite minimum length.

Such methods are bound to be adopted if grades are to have any real meaning; as the first essential of a grade is its reliability. Sisal can never be obtained as a uniform product under any system of grading; but it *can* be produced so that its variability can be precisely defined.

Coffee Shade in Kenya

By T. L. McCLELLAND, *M.C., Plant Inspector.*

Coffee is grown under varied climatic and other conditions in Kenya, and consequently shade trees, also to be grown under these varied conditions, cannot be recommended as suitable in any district without experimentation.

The question of shade has been too expansive for the Department of Agriculture to undertake as routine experimental work, and the principle adopted has been to invite the co-operation of planters in the different districts to carry out trials with various trees. Until the results of these trials, over a reasonable period of years, are obtained, the policy of the Department must be, with few exceptions, not to make recommendations but suggestions.

In 1922 a Committee arranged by the Coffee Planters' Union issued a report on shade trees, from which the following passage is quoted:—

> "It is recommended that no single tree be chosen and planted exclusively, but that a mixed shading programme be adopted of trees likely to suit the particular locality concerned and distributed as to varieties throughout the plantation. This plan has the double advantage that trees which are subsequently found unsuitable may be removed without seriously depleting the shade, and that in the case of deciduous trees when one variety is leafless another may be in foliage."

It is regretted that the above recommendation has not been followed as closely as might have been expected. Records go to show that in many districts where shade is being found to be definitely beneficial, many planters have in the past discarded the trial, and, as a result of not seeing the experiment through, the shade position, instead of being well advanced, is still in its infancy. Until the plan is adopted by planters and carried out consistently, very little progress will be made in regard to the selection of the most suitable trees for any particular district.

Other countries have precisely similar difficulties to contend with as Kenya, and in this connection the following quotation from the *Indian Scientific Agriculturist* may be of interest:—

> "It does not do to dogmatize as to any particular tree or trees fulfilling all the requirements of shade for coffee, having regard to the varying conditions under which the fragrant berry is grown. Trees under which coffee thrives in one district prove positively deleterious to the plant in another, perhaps not a dozen miles away. The great rule to observe in the question of shade is, where the coffee is doing well, not to interfere. This useful rule is sometimes honoured in the breach rather than in the observance. Some planters not infrequently take a prejudice against certain trees, and, irrespective of the fact that the coffee under them is in a flourishing condition, ruthlessly eliminate them. Where, of course, trees are observed to have a detrimental effect on the coffee, after other means have been tried to improve it without success, it is the right thing to do to get rid of them after providing temporary shade."

The whole question of coffee shade actually has resolved itself to a process of trial and elimination of those trees found unsuitable.

Characteristics Desirable in Shade Trees.

Deep rooting, as surface feeding roots are apt to exhaust the soil of moisture, to the detriment of the coffee bushes; a wide-spreading habit; production of good mulch; a light foliage habit; toughness, in order to withstand excessive wind and hail; immunity to the ravages of pests and diseases.

Trees combining all these characteristics are the exception rather than the rule, and thus selections have to be made combining as many as possible of the points. While it would be an advantage to select leguminous trees, a non-legume should receive just as much consideration if it conforms with the main characteristics of a shade tree and is not detrimental to coffee bushes when in close proximity.

ADVANTAGES GAINED BY ESTABLISHMENT OF SUITABLE SHADE TREES.

Shading the soil, (*a*) to conserve moisture, (*b*) to prevent loss of humus.

Providing mulch, which increases the humus content of the soil.

Protection from excessive wind and hail.

In the case of leguminous trees, benefit to the soil from the fixation of atmospheric nitrogen through the agency of the roots by bacterial action.

Reduction of extremes of temperature; this brings about a more uniform growth thus eliminating a great deal of handling and centreing.

Equalization of crops: coffee grown under well-regulated shade does not tend to overbear, and the result is a more uniform crop annually.

Elimination of rapid temperature changes, thereby controlling what is commonly known as "hot and cold disease".

Equalization of temperature by means of shade appears to be one of the main factors in controlling "Elgon Dieback".

COFFEE SHADE TREES.

The following is a list of trees which have been tried as coffee shade in different districts: —

**Acacia* sp.—White Thorn.
†*Acacia* sp.—Red Thorn.
**Acrocarpus fraxinifolius.*
**Albizzia fastigiata.*
**Albizzia lebbek.*
‡*Albizzia lophantha.*
**Albizzia moluccana.*
†*Albizzia stipulata.*
**Calpurnia aurea.*
†*Cassia didymobotrya.*
†*Cassia goratensis.*
†*Cedrela toona.*
**Commiphora* sp.
**Cordia holstii.*
‡*Crotalaria agatiflora.*
‡*Crotalaria* sp.
**Croton macrostachys.*
**Croton megalocarpus.*
**Cytisus alba.*
**Dalbergia assamica.*
†*Dalbergia latifolia.*
†*Erythrina indica.*
†*Erythrina lithosperma.*
†*Erythrina tomentosa.*
†*Erythrina umbrosa.*
**Erythrina* sp.
**Ficus mallatocarpa.*
†*Ficus hochstetteri.*
**Ficus* sp.
**Grevillea robusta.*
**Gliricidia maculata.*
**Inga vera.*
†*Jacaranda mimosæfolia.*
**Machærium tipa.*
‡*Maesopsis berchemoides.*
**Milletia oblata.*
**Musa sapientum*—Banana.
**Pithecolobium saman.*
**Ricinus communis*—Castor Oil.
†*Schinus molle.*
**Sesbania punctata.*
**Trema guineensis.*
**Vernonia senegalensis.*
†*Vitex keniensis.*

* See notes on individual trees.
† Unsuitable.
‡ Under trial.

NOTES ON INDIVIDUAL TREES.

Permanent Shade Trees.

Acacia sp. (Mimosaceæ), *Munyenya* (Kikuyu); White Thorn. — This tree makes an excellent spread, and coffee, in most cases, grows well under it. Owing to its excessively thorny nature it is difficult; if not impossible, to regulate the shade, and for this reason it cannot be recommended. It is stated that after

pruning dry rot sets in and the tree dies out.

Acrocarpus fraxinifolius (Leguminosæ).—A recent introduction and worthy of trial. Reports state that this tree reaches a height of 30 feet in three years in the Elgon District at an altitude of 6,700 feet. It is therefore in demand, owing to its rapid growth and the protection it affords coffee from hailstorms.

The following extract regarding the tree is taken from the *Indian Scientific Agriculturist*: "*Acrocarpus fraxinifolius* and *Cedrela toona* have been found unsuitable for coffee. The objection that they are subject to scale has already been noticed. In addition, the foliage of the former is not dense enough for dry situations."

It will be noted from the previous list that *Cedrela toona* was tried in Kenya and found unsuitable.

Until more is known about the habits of the tree it is difficult to make any recommendations regarding the spacing, but it might be tried out at distances of 36 ft. or 45 ft.

Albizzia fastigiata (Leguminosæ); *Set* (Nandi).—A tall tree with a large spreading crown. Is under trial in the Lumbwa and Nandi areas. Reports go to show that it is slow growing. For a fully grown tree the spacing would be possibly from 45 ft. to 54 ft.

Albizzia lebbek (Leguminosæ).—Slow growing, but forms a good canopy when established. Lends itself to pruning and shade regulation. Appears to be satisfactory in the Fort Ternan area. Suggested spacing, 36 ft. by 45 ft.

Albizzia moluccana (Leguminosæ).—This tree showed promise as a permanent shade in certain districts, but is subject to a root fungus which eventually causes death to the tree, unfortunately when it is fully grown and beneficial to the coffee. The establishing of *Albizzia moluccana* is not advocated owing to the possibility of the occurrence of this disease. The wood of the tree is very brittle and therefore subject to extensive damage from heavy storms.

Commiphora sp. (Burseraceæ); *Mukunguku* (Kikuyu).—Mr. Battiscombe, late Conservator of Forests, Kenya, described this tree as fast growing, but this has not been the experience of those planters who have given it a trial for shade in coffee. On the contrary, it has been found rather slow growing. The tree does best at altitudes up to 5,500 feet. It develops a very deep root system, and coffee thrives well under it. It is considered worthy of further trial in the Nyanza Province. Grows readily from cuttings; small stakes were distributed in the past, but it is considered that owing to slow growth the cuttings should not be less than five or six inches in diameter. Suggested spacing, 18 ft. by 27 ft.

Cordia holstii (Boraginaceæ); *Muringa* (Kikuyu).—Indigenous tree, reaching a height of 50 feet when grown in the open. It has a large spread, is deciduous, heavy foliaged, and gives a good mulch. Easily propagated from seed. The seed should be soaked in lukewarm water for twelve hours previous to planting, and planted in boxes. It has been found that germination is extremely bad unless fresh seed is procured. There are varied opinions amongst planters regarding this tree, but in many districts it has shown good promise. It has been experienced that pruning the tree during the first three years of its growth is detrimental, and it is suggested that the removal of lower branches should not be carried out until the tree has at least attained this age. In any case, no branches should be removed at the point where the vertical growth is green wood. Should not be planted in mealy-bug areas owing to its susceptibility to attacks by *Pseudococcus lila-*

cinus Ckll. Suggested spacing, 36 ft. to 45 ft.

Croton macrostachys (Euphorbiaceæ); *Matundu* (Kikuyu).—This tree has been tried in some of the wetter districts, and is found, from a moisture point of view, to be very exhausting to the soil; it is consequently undesirable owing to its effect on the coffee bushes.

Croton megalocarpus (Euphorbiaceæ); *Mukinduru* (Kikuyu).—This tree, like the previously mentioned species, competes with the coffee bushes for moisture, which is most unfortunate, as it has most suitable shade characteristics. Its spread closely resembles the famous *Inga vera* shade tree of Central America. Owing to the excessive competition for moisture and the consequent effect on coffee bushes, both the *Croton* species are being eliminated from any further trials.

Dalbergia assamica (Leguminosæ).—A recent introduction, which promises to be useful as a permanent shade tree. It is as yet too early to make any special comments on the tree. Suggested spacing, 27 ft. by 27 ft.

Erythrina caffra—Kaffir boom (Leguminosæ).—An importation from South Africa. Slow in early stages, but later grows fast. Good spread, and reports state it requires little pruning; grows readily from large cuttings. Suggested spacing, 27 ft. by 27 ft.

Ficus mallatocarpa (Moraceæ); *Mukuyu* (Kikuyu). — Coffee looks well when planted under *Ficus mallatocarpa*, self-sown, and established before the coffee is planted. Growth is slow, and owing to its dense habit, particularly at altitudes of 5,500 feet and over, it is not popular with planters. The tree requires considerable shade regulation. If grown, should be spaced at approximately 45 ft.

Ficus sp. (Moraceæ).—Indigenous in the Trans Nzoia. Shows good promise in the Cherangani area. Its habit of growth is not so dense as that previously mentioned, which simplifies shade regulation. A fully grown tree has an excellent spread, and would necessitate a spacing of approximately 45 ft. by 45 ft.

It would appear from reports of planters that it is more easily propagated from seed than cuttings.

Grevillea robusta—Silky Oak (Proteaceæ).—This tree is extremely popular with many planters, although it has not got the fundamental characteristic of a shade tree, namely, canopy. In certain districts, where rainfall is deficient, it has been noticed that coffee in the immediate vicinity of this shade suffers from too much competition, more particularly when the tree reaches the age of ten years and over. It is considered that if proper pruning was adopted *Grevillea robusta* would be more useful as a shade tree than it is to-day, and in order to attain this it is suggested that the tree be topped at 30 to 35 ft. and all the small and closely spaced lateral branches removed in order to get a greater spread and a filtered shade. When the tree is pruned in this manner it has the appearance of being spiral pruned. Suggested spacing, in a mixed shade programme, 36 ft. by 36 ft.

Gliricidia maculata—Madre (Leguminosæ).—Promised to be one of the most suitable shade trees for the lower altitudes, but owing to its susceptibility to attacks by the mealy bug, *Pseudococcus lilacinus* Ckll., trials unfortunately had to be abandoned. The tree makes good growth around Koru, and is worthy of further trial in the lower areas of the Nyanza Province. Grows readily from cuttings or seed. Suggested spacing, 27 ft. by 27 ft.

Inga Vera (Leguminosæ).—Several attempts have been made to establish this tree from seed imported from the

West Indies and Central America. The only success attained was by Messrs. Norton and Giffard, Upper Kiambu, who succeeded in establishing one tree, which has made satisfactory growth, but to date has not seeded. Mr. A. D. Trench (Senior Coffee Officer), during a recent visit to Tanganyika, discovered a few *Inga vera* trees growing on a plantation belonging to the Amani Research Station. Seeds were collected and brought to Kenya, in order that further trials may be carried out.

Machærium tipa (Leguminosæ).—This is a large tree, attaining a height of over 50 ft.; good spread of from 27 ft. to 30 ft.; fairly good mulch; quick growing; deciduous. In some districts, where the rainfall is not very heavy, it has proved unsuitable, but is still under trial in the wetter districts. Grows readily from seed. Suggested spacing 36 ft. by 45 ft.

Milletia oblata (Leguminosæ); *Mwangwa* (Kikuyu).—A small deciduous tree, reaching a height of from 24 feet to 30 feet. Is fast growing, and has exceedingly tough wood. Promising as a permanent shade in many districts. Easily propagated from seed, and can be planted at stake. Suggested spacing, 27 ft. by 27 ft.

Pithecolobium saman—Rain tree (Leguminosæ).—This tree is included in these notes, as a planter at Koru states that it is one of the most suitable trees he has found for shade in that district. It is apparently extensively used for the purpose in the West Indies, Central America and Ceylon. Reports state that it is long lived, and stands lopping well. It grows with a short thick bole, with extremely long horizontal branches, which would possibly necessitate a spacing of 54 ft. by 54 ft.

Trema guineensis (Ulmaceæ); *Muhethu* (Kikuyu).—This tree which is very fast growing, was tried by several planters in Ruiru and Kiambu Districts, and found most unsuitable, owing to its competition with coffee for moisture. In some of the wetter districts, where it is desired to establish uniform shade as quickly as possible, this tree might be found suitable and is therefore suggested. The Senior Coffee Officer, during a visit to Tanganyika, reported on a variety of this tree called Mwezi as follows: "I was surprised to see how well coffee was thriving under this tree. Mr. Harvey, Agricultural Officer, Northern Province, informed me that there are two varieties on Kilimanjaro, and that the light coloured bark tree was found unsuitable. I saw many instances where coffee was doing well under Mwezi, and for this reason I would suggest that the tree be given a more extended trial. I do not consider, however, that it will be suitable in a dry area. It grows very rapidly, and is a surface feeder."

Mr. Sanders, Coffee Experimental Officer, Tanganyika, states that it branches evenly and the degree of shade can therefore easily be controlled.

Semi-permanent and Temporary Shade Trees.

Calpurnia aurea (Leguminosæ); *Mwethia* (Kikuyu).—This tree might have been more generally adopted as a semi-permanent shade if it were not so subject to defoliation by caterpillars. It appears, however, that when it reaches maturity caterpillar attack is not so severe. Even including the above disadvantage, it is nevertheless popular with planters in some districts. Suggested spacing, 18 ft. by 27 ft.

Cytisus alba (Leguminosæ).—An exotic tree which is native to the Canary Islands. It is a fast growing temporary shade, but has not been found as satisfactory as *Sesbania punctata*. If transplanted will die out more rapidly than if seed-sown at stake. The tree in Kenya

is usually, but wrongly, called Tree Lucerne—the true Tree Lucerne being *Cytisus proliferus*. Suggested spacing, 18 ft. by 18 ft.

Musa sapientum—Banana (Musaceæ).—Bananas in the first instance were tried as a temporary shade in Kenya, owing to their almost general employment for this purpose in Costa Rica. They have been found most unsuitable, and are not recommended.

Ricinus communis—Castor Oil Tree (Euphorbiaceæ).—This tree is being used by certain planters in the Nyanza Province for temporary shade. From observations it is considered that the tree is entirely unsuitable for this purpose. It has a habit of suddenly dying out, thereby leaving the coffee bushes suddenly exposed. It also brings about a yellowing condition of the coffee bushes, is a surface feeder, and also subject to attacks of borers and root disease. Although for the first twelve to eighteen months coffee looks well under the castor tree, its effects are felt eventually, and therefore the growing of the tree for shade is to be discouraged.

Sesbania punctata (Leguminosæ); *Mwethia* (Kikuyu).—Although there are several species of *Sesbania*, the above-mentioned is found to be the most suitable as a temporary shade. When first used for this purpose, the tree was not only unfairly abused but grossly neglected. It is a fast grower and a gross surface feeder, and for these reasons when attention has not been given to proper shade regulation its effect on coffee bushes has been detrimental. Within recent years more attention has been given to the question of shade regulation, with the result that *Sesbania punctata* is giving better results and is becoming more popular with planters. In fact, some planters are so satisfied with its shade effect that, rather than establish permanent shade, they concentrate entirely on renewing *Sesbania* from time to time—a practice which is not advocated, as it is considered, where shade is essential, trees of a permanent class, found suitable to the particular district, must be established.

Vernonia senegalensis (Compositæ); *Mororowet* (Nandi).—This tree is indigenous to the Nandi Reserve, and possibly elsewhere in the Nyanza Province. Is showing good promise, and may be of great value as a semi-permanent shade. It has been stated that the tree is short-lived, but reports from Kaimosi go to show that *Mororowet* is still going strong after ten years. Suggested spacing, 18 ft. to 24 ft. apart.

Inquiries have been received from time to time as to the suitability of Eucalyptus for shade. All species of Eucalyptus, including Blue Gum and Red Gum, have been found very detrimental to coffee, not only in close proximity but their effect may be felt as far away as 60 ft. They are also not recommended as windbreaks. The foregoing remarks apply to *Acacia mollissima* (Black Wattle) and *Cupressus macrocarpa*, both of which are sometimes used as windbreaks.

Shade Regulation.

Judging from departmental reports made from time to time it would appear that a setback to the advancement of shade culture in general may be due to the lack of knowledge of the planter in regard to shade regulation. Times innumerable it has been reported that coffee in such and such a district was suffering from the effects of over-shading. Although it is almost unbelievable, records also show that, in some instances, there have actually been more temporary shade trees planted than coffee plants, without any attempt being made to thin out or to regulate the shade, with the

result that the coffee bushes are to all intents and purposes unproductive.

The point I wish to stress here, and it is a point on which authorities on the subject are adamant, is that, providing a suitable tree or trees are found to suit a particular locality, the future success of the shade is the regulation thereof. Correct shade regulation naturally hits the happy medium between between overshading and insufficient shade, and in this respect the following extract, which may be of interest to planters in Kenya, is taken from a bulletin entitled *Coffee: Its Cultivation and Manuring in South India, by* R. D. Anstead, M.A.:—

> "Between these two extremes lies the golden mean, which may differ from estate to estate, and depends upon its aspect, rainfall and elevation. Each coffee-grower must find out for himself the best amount of shade for his particular garden and keep it regulated to that amount.
>
> "It is a good plan to so arrange the shade that it is produced by a number of different trees, not all of one variety, and to have shade trees of different ages and sizes through the estate.
>
> "Every year or so the shade will need to be lightened; that is, the shade trees must be pruned and lopped where the shade is too heavy so as to let in a little more light. This is work which requires a great deal of care and judgment. The shade trees must be lopped carefully, since their health is important, and on them depends to a large extent the health of the coffee below."

It will be seen from the foregoing extract, not only the importance of shade regulation, but of planters making careful observations and experiments in order to obtain a result as near as possible to the ideal which suits their own particular conditions.

Spacing.

In dealing with spacing of shade it should be understood that a certain amount of latitude is given regarding the mathematical accuracy of the distances suggested. These distances should be taken more as a guide than for strict adherence. Also, in mixed shading, exact geometrical patterns of each particular tree need not necessarily be considered as essential, but rather the different varieties interspersed and planted at approximately the requisite distances for the shade required.

In planting between coffee it would seem desirable that the shade tree should be planted close to a coffee tree, and eventually, when it has developed to the extent that the coffee plant is suffering from the effects of the competition of the tree in close proximity, the coffee plant might be removed.

This is a case of really substituting a shade tree for a coffee tree, and the idea of planting shade in this manner, rather than between the coffee bushes, is to avoid having possibly four poor specimens of coffee bushes in close proximity to the shade. The substitution system has never become popular with planters.

As stated previously in this article, until a specific tree has been found suitable for a district a plan of mixed shading should be adopted, and when this plan is carried out it is safer to err on the side of overcrowding, as it is much simpler to remove superfluous shade than to establish it. In drier areas, however, due consideration must be given to the danger of exhausting the soil of moisture.

Artificial Shade.

Artificial shade is the term applied to the erection of a canopy on poles over coffee trees. In many ways the effect is equivalent to that of well regulated tree shade, and while no mulch, and consequently no increase of humus, is added to the soil, there is a balancing factor in that there is no competition for moisture, and it should therefore be considered for

those areas where shade is necessary, but where the rainfall is too scanty to support both coffee and shade trees. It is also applicable to districts subject to hail, and to cold areas, particularly where the rate of change between day and night temperatures is rapid.

This type of shade was originally suggested by Mr. M. D. Trench, formerly Inspector of Coffee Plantations, but was developed on a field scale by Mr. S. O. Hemsted, Soy, who some years ago artificially shaded about 50 acres of coffee. The coffee on this plantation was being grown under not too ideal climatic conditions, and the effect of the shade was to produce a more open type of growth, which considerably simplified pruning; the trees generally appeared much healthier, and bore regularly more uniform crops, and consequently produced a more remunerative yield.

Irrespective of the method of erection there are three distinct types of artificial shade, as follows:—

Complete Shade, in which the canopy is continuous over the whole *shamba.*

Belt Shade, in which the canopy is continuous along the row, with a space left between rows.

Individual Shade, in which the canopy consists of a square of approximately 5 ft. 6 in. in size immediately over each tree.

From the results of the various types, the writer concludes that the most satisfactory is belt shade, and details of construction as given in this article will be confined to this method.

Details of Construction.

While many observations have been made on various estates in regard to the construction of artificial shade, and most grateful acknowledgment is made to those planters who have given the Department the benefit of their experience, it is the writer's opinion that Mr. Hemsted's shade, as a fundamental basis for this type of work, is probably the most satisfactory. The accompanying diagrams are therefore based on his present system.

Two main features are evident in this shade, namely, its permanent nature and the fact that it can be regulated. The latter is an important factor, as much of the success of the shade is, as in tree shade, due to proper regulation. It may be found that even on a single plantation the percentage shade to obtain the best results may vary considerably, and therefore an erection of such a nature that this can be controlled needs no further comment.

It will be seen from the diagrams that the coffee in this case is planted 10 ft. by 7 ft., but the principle of the shade and erection may be applied to the more usual spacing practices employed in Kenya.

Fig. 1 shows a plan of the shade, giving the spacing of posts in relation to coffee trees. A single wire runs over the top of the posts in the direction of the shorter spacing of the latter. This wire is securely fastened to the top of each post with staples, and is the main bearer for the two wires which run longitudinally, or in the direction of the greater spacing of the posts. These two wires are spaced 5 ft. apart, or 2½ ft. each side of the centre of the tree, and are secured to each single bearer by means of wrapping with a piece of thin pliable wire. On the two longitudinal wires rests the canopy. A further wire runs centrally over the top of the canopy to hold it in position.

Canopy.

The canopy material should be light and reasonably durable. From a number of materials used, the two most satisfactory would appear to be bamboo and

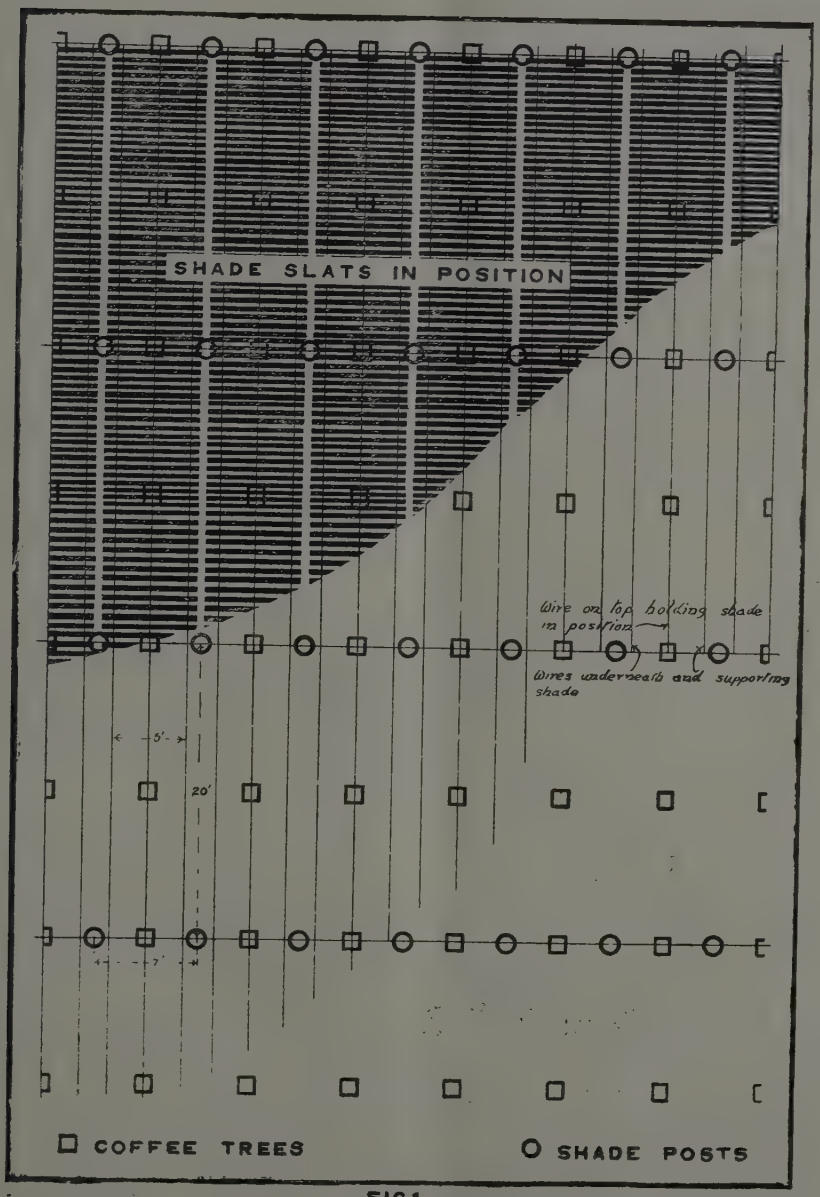

SHADE SLATS IN POSITION
Wire on top holding shade in position
Wires underneath and supporting shade
5'
20'
COFFEE TREES
SHADE POSTS

FIG. 1

sisal poles. The latter, while possibly not so durable as bamboo, lends itself to easy preparation. The poles are cut to the required length, in this case 6 ft. 6 in., and the task of splitting these lengths into slats is easily accomplished by a boy merely slicing them down with a *panga*.

Fig. 2. End and side elevations. These sketches again show the position of the posts in relation to the coffee trees. It will be noted, as in the plan, that the post spacing in coffee planted 10 ft. by 7 ft. is 20 ft. by 7 ft. The height of the posts is 8 ft. from ground level, and in this connection it will be found more satisfactory, under artificial shade, to adopt the single stem system of pruning rather than the multiple stem system.

The two sketches are self-explanatory.

Fig. 3. This drawing shows Mr. Hemsted's method of anchoring the end or straining posts. A wedge-shaped piece of soil, having the side towards the post cut perpendicular, is excavated to a depth of 3 ft. The actual anchor used is the ordinary steel railway sleeper. This is laid on edge in the excavation, and resting flush with the perpendicular side. Two holes are then bored with a crowbar through the solid earth, into which are threaded the stay wires. Each wire is attached to its respective slot in the sleeper and the hole filled in.

The object of boring the holes with a crowbar is to ensure that the stress on the anchor is against a solid wall and not against loose earth.

The steel sleeper is immune to the ravages of termites, and will remain efficient for many years.

Fig. 4. Each single bearer wire is in line with an end post and is therefore attached directly to it.

It will, however, be noted that no posts coincide with the three longitudinal wires, and these are therefore attached to a cable composed of several strands of wire which is fastened near the top of each end post.

It will greatly facilitate erection if there is a line of trees, such as a windbreak of *Grevillea robusta*, convenient to the edge of the plantation. The cable mentioned above can be attached to the trees at the proper height, thereby eliminating erection of end posts and anchors.

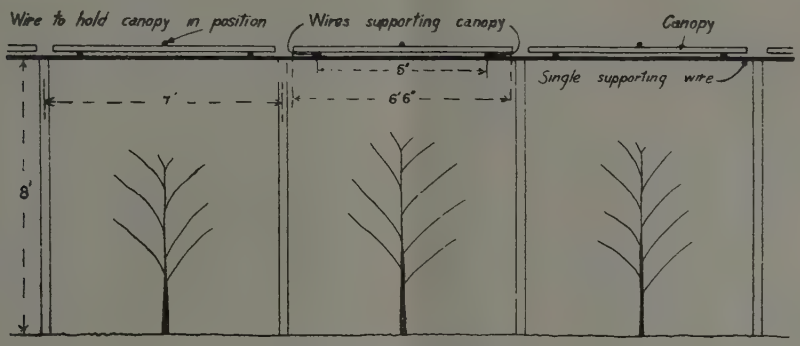
Treatment of Posts.

Irrespective of whether the wood of the posts is resistant or not to the ravages of termites, it is necessary to treat it with some wood preservative, particularly that part of the post underneath surface level.

Painting with the preservative is only a very temporary measure, and would necessitate excavating the earth round each post and painting annually, or even more often. The more permanent and satisfactory method of treatment is as follows:—

The wood preservative is put in a tank, say a 40-gallon steel oil drum, with one end removed. The posts are then placed on end in the preservative, and a fire lighted underneath the tank. As the heat increases, the air is expelled from the pores of the wood, and by allowing the posts to remain in the preservative during the cooling process the liquid enters the vacuum created and thoroughly permeates the wood.

Care must be taken that too high a temperature is not reached during the heating process, as there is always a danger of the preservative catching fire.



END ELEVATION

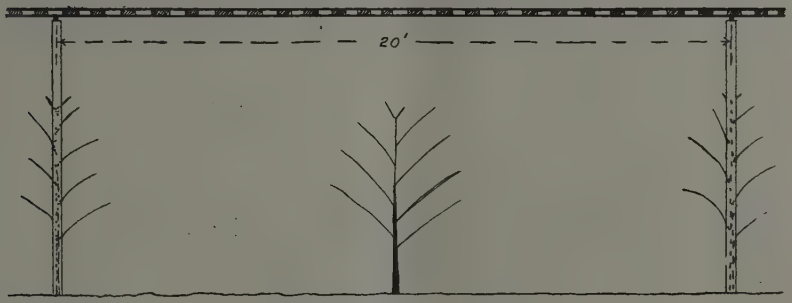


FIG. 2 SIDE ELEVATION

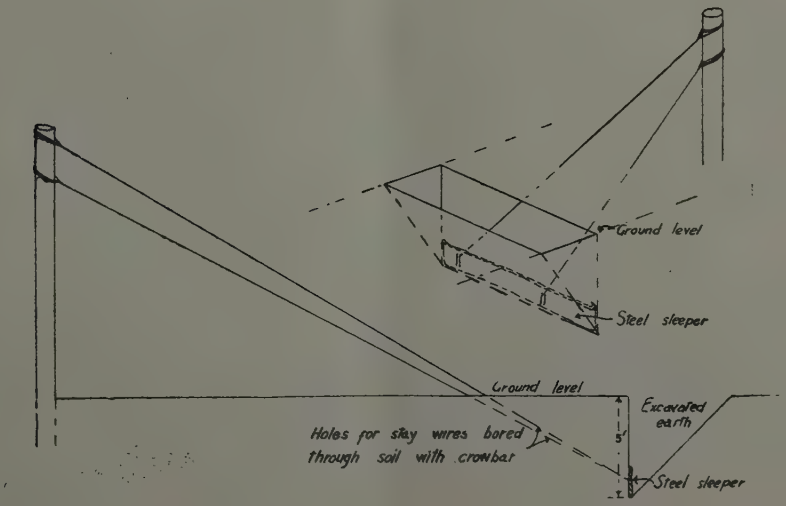


FIG. 3 ANCHOR FOR END POSTS

Materials Used.

Wooden posts, minimum diameter 6 inches.
Single bearer wire, steel, gauge 8.
Longitudinal wires, steel, gauge 12 x 4.
Canopy, sisal pole slats.

Cost of Erection.

The total cost of erection is £10 per acre, and the estimated depreciation is 10 per cent per annum.

It is realized that the high cost per acre will be a deterrent to many planters from erecting artificial shade where it would be beneficial, and while a temporary type of shade is not generally advocated, it is suggested that a few acres of such shade should be established as an experiment, and careful observations made on improvement of coffee trees and yield. If results are of an encouraging nature and remunerative crops experienced, a more permanent shade of the type described should be considered.

In conclusion, the thanks of the writer are due to those planters, particularly Mr. S. O. Hemsted, who have materially assisted this Department by experimental work and reports on coffee shade, and to Mr. A. D. Trench, Senior Coffee Officer, for his many helpful suggestions.

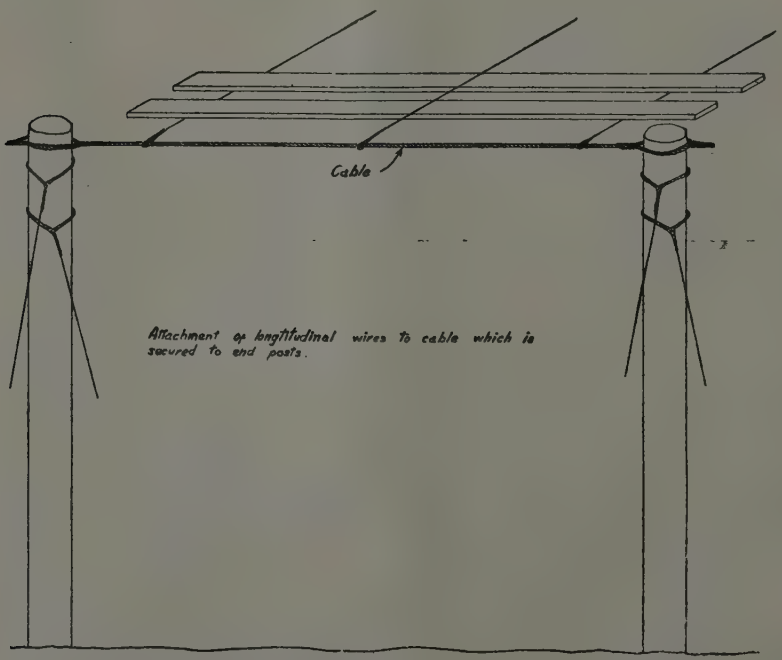


FIG. 4

Leaf-eating Caterpillar of Coffee

(*Metadrepana andersoni* Tams.)

By F. B. NOTLEY, *B.Sc. (Hons.), A.I.C.T.A., F.R.E.S., Entomologist, Kenya.*

The leaf-eating caterpillar of coffee was first recorded in Kenya from Kamolet and Mboga Vale, Songhor, in 1922, when it was recognized as a new species of Drepanid by Mr. T. J. Anderson, Entomologist. It was named *Metadrepana andersoni* by Tams in 1925. Since then it has been recorded from coffee from various places in Nyanza Province and the Trans Nzoia. It has not yet been recorded east of Londiani. This and a related species of *Metadrepana* have been recorded from Uganda, namely, *M. marantica,* and the latter has been recorded from Bukoba, whilst *M. pallida* has been described from coffee in Northern Nigeria.

Outbreaks of *Metadrepana andersoni* usually occur between the months of July and November, but have occurred in every month of the year. Usually, if no steps are taken to check the outbreak, about fifty to one hundred acres of coffee are completely defoliated, after which natural parasites seem to get the upper hand, and the insect disappears. There seems no doubt that there is some indigenous natural host plant on which the insect normally maintains itself, but what this host plant is has not yet been discovered.

After a tree has been defoliated by *Metadrepana* it seems never to recover properly nor to bear a good crop for a considerable number of years, and it would appear that the most economic method to induce rapid recovery is to stump the tree. Thus the loss incurred through this pest is considerably greater than would at first sight be imagined. Owing to lack of data the total loss of crop due to the pest cannot be estimated, but it should be remembered that whilst this may be small, the loss is borne by a few individuals and is consequently felt very heavily by them.

The object of this article is to familiarize planters with the insect, and particularly with the early stages of its damage. All the losses incurred are due to the planter not being alive to the potential danger early enough, and not taking the necessary steps to check the outbreak before the damage is done.

The most obvious stages of *Metadrepana* are the full-grown caterpillar, but by the time these are present in numbers the major part of the damage has already been accomplished. The stages of the insect will therefore be described from the egg onwards in order.

THE EGGS.

These are small oval decorated bodies about 1/20th of an inch long and half as wide. When first laid they are creamy white, but after a few hours they become bright red. Later, on the day before hatching, they turn a dark blue-black colour. They are laid singly on the leaf, almost always on the under surface, and usually towards the centre of the leaf. The egg takes eight or nine days from the time of laying until it is hatched.

THE LARVA OR CATERPILLAR.

The young larva is dark green in colour. In the first stage a close examination shows that the colour is a dark green striping on a lighter ground colour. The head is purplish. The thorax, or chest, is large, and the abdomen bears a small "tail" projecting upwards and backwards. There are no terminal prolegs; that is,

the caterpillar has three pairs of walking legs on the thorax and four pairs of stumpy legs on the abdomen, but, unlike most caterpillars, does not have a pair of legs at the extreme hind end of the body.

The larva grows larger, shedding its skin from time to time, and the larger stages are variable in colour from a dark green or purple to a deep velvety brown. The thorax becomes relatively larger, giving the caterpillar a hump-backed appearance. The "tail" is present throughout the larval stages, but in the older larvæ is usually not pointed upwards but backwards. The caterpillars are smooth and fleshy, though a few hairs are present.

It is a common belief that these caterpillars can sting. This belief owes its origin partly to the fact that another leaf-eating caterpillar of coffee, namely, *Parasa vivida*, is provided with stinging hairs, and partly to its somewhat fearsome appearance. The belief, however, is quite without foundation, and the caterpillars may be handled with impunity.

The caterpillars lay down wherever they go a strand of silk, and if alarmed will drop down a foot or more on this

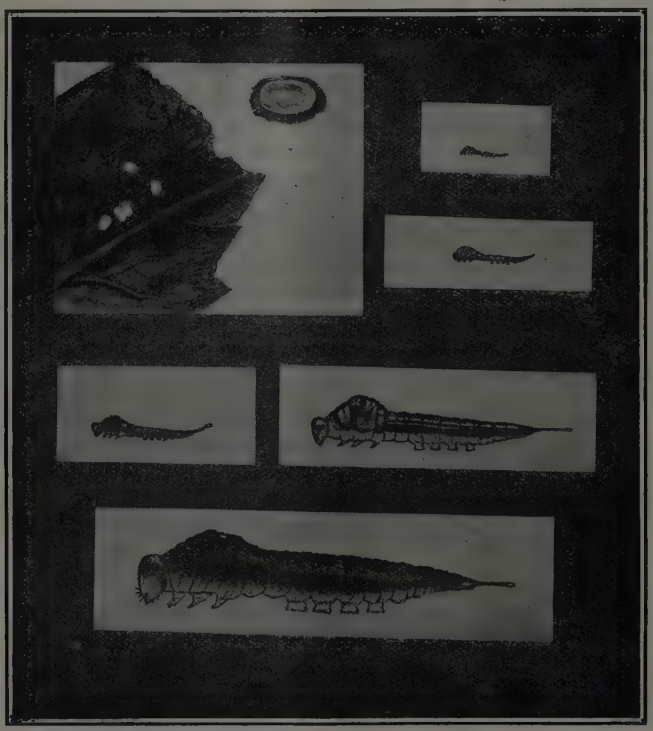


FIG. 1.—Eggs on a coffee leaf (×4), and a single egg (×16).
FIGS. 2, 3, and 4.—First three stages of the caterpillar (×2).
FIGS. 5. and 6.—Last two stages of the caterpillar, natural size.

silk, hanging thus suspended in the air. Later they climb back by rolling up the thread.

The young stages feed on the lower epidermis of the leaf, leaving the upper surface intact. They always choose a part of the leaf about half way between the edge and the midrib. In the youngest stage of all, the larva keeps the body still and moves the head from side to side, thus eating out a peculiar sort of hieroglyphic. Slightly older larvæ eat the whole lower surface of a small area of leaf. Where there are a number of larvæ on the same leaf a patch may appear on the leaf extending all round it at a little distance from the edge; this patch rapidly turns brown.

Little damage is done by these young stages, but it is this damage which it is essential that the planter should recognize if he is to check the outbreak in time.

This damage may be confused with certain other conditions, particularly with *Hemileia*, leaf-miner moth, and the

Fig. 7. - Adult female, natural size.
Fig. 8.—Adult male, natural size.
Fig. 9.—Adult in resting position, natural size.
Fig. 10.—Pupa, natural size.

feeding of a small caterpillar, *Epiplema dohertyi*. Where *Hemileia* leaf disease is the cause, however, the actual surface of the leaf is not damaged, and the bright orange-coloured spores may usually be seen on the under surface. If the spot is due to leaf-miner, both surfaces of the leaf will be intact, but the inside will have been eaten away. On bending the leaf over the spot, one surface will usually crack, exposing the tunnelled area beneath.

The damage due to *Epiplema dohertyi*, which is a small white or pinkish caterpillar, is very similar to that of *Metadrepana*, but usually only occurs in the centre of the coffee tree, and the areas eaten are usually much larger and nearer the centre of the leaf. All except the upper epidermis and veins is eaten, and the leaf is skeletonized in the area which has been damaged; the spot is therefore not brown. *Epiplema dohertyi* has only been recorded from the Sotik area, and does not do sufficient damage to be regarded as a pest. The caterpillar itself is small, white and rather "pimply", and usually lies in the leaf with its body curved in the shape of a crescent.

The older stages of the larva eat the whole thickness of the leaf, leaving the midrib only. When present in large numbers they defoliate the tree, and may then be driven by hunger to gnaw the berries and bark.

The larval stage lasts about 28 to 30 days.

THE PUPA OR CHRYSALIS.

At the end of the larval stage the full-grown caterpillar rolls up a leaf, usually by bending one side of the leaf to the midrib, and secures it with silk. The open end of the cone so formed is then closed with a pad of silk, and the

FIG. 11.—Coffee tree, defoliated by *Metadrepana*.

larva remains quiescent for one day. After this it sheds its skin and becomes a typical brown pupa or chrysalis. This stage lasts from 12 to 14 days. At the end of this period the adult moth appears, usually towards the evening.

FIG. 12.—Coffee leaf, showing the damage caused by the young stages of *Metadrepana*.

THE ADULT.

The adult moth has a wing spread of about 1½ inches, and varies in colour from a silvery grey to deep brown or mottled purplish-black. The male is lighter in colour than the female, and has at the end of the abdomen a pair of short feathery claspers. The moths may be seen in daylight resting on the underside of leaves with the wings held outspread, as is illustrated in Fig. 9. Copulation occurs at night, and usually continues throughout the following day, the moths resting tail to tail with their wings overlapping until about 5 p.m., when they usually separate. Copulation usually occurs on the second day after the emergence of the adult moth.

Immediately after copulation, the female commences to lay eggs. In captivity the greatest number of eggs is laid on the first night, but egg-laying may continue for five nights, after which the female dies. Twenty-nine females bred in captivity and unfed from the time of emergence laid an average of 76 eggs each, whilst twelve females bred in captivity and fed after emergence on sugar solution laid an average of 109 eggs each. These figures suggest that normally the adult does feed, probably on nectar or drops of dew on the leaves, but probably bear little relation to their capacity for laying in the free state, since one female actually laid a total of 564 eggs in four nights. It seems probable therefore that under normal conditions the number of eggs laid by each female is very high.

The proportion of males to females is about equal. Egg-laying takes place quite freely without the females having been fertilized, but such infertile eggs never hatch.

The total time required for one generation is then about 50 to 53 days. The large number of eggs which may be laid, however, explains the reason for the sudden appearance of the caterpillars in overwhelming numbers in the plantation.

So far as is known, the caterpillars will not feed on any plant but coffee. At various times planters have maintained that the caterpillars have been seen feeding on *Sesbania, Calpurnia, Grevillea* and maize, but under experimental conditions it was found that caterpillars confined with any of these plants and given no choice of food died of starvation without attempting to feed. It is probable that the mistake was made of assuming that since the caterpillar was on these plants

it was feeding upon them. The first three plants are grown as shade trees in coffee, whilst maize is often planted as either a catch crop or a temporary shelter in young coffee. When food becomes scarce in a heavy infestation the caterpillars wander off the coffee trees and often climb any other plant they find, very often dropping on long strands of silk if they find themselves on unsuitable food.

It is almost certain, however, that some natural host plant other than coffee exists, and it seems likely that this plant may be found in the forests west of the Rift Valley. Our knowledge of the climatic requirements of the pest is not sufficiently complete to say whether it would cause serious damage to the coffee areas east of the Rift Valley if introduced there, but in captivity the moths breed even more readily in Nairobi than they do in captivity in Nyanza. Considerable difficulty, in fact, was encountered in inducing copulation in captivity in Nyanza, when part of the same brood of insects sent down to Nairobi showed no disinclination to copulate in captivity. It seems probable, however, that outbreaks of *Metadrepana* usually occur from infestations originating in the forests, and the absence of forest from the main coffee growing areas of the Central Province would make such outbreaks unlikely. Further, the different climate, especially the lower humidity, may make the development of *Metadrepana* in the Central Province impossible; insects raised in captivity are always, unless special precautions are taken, subjected to a higher humidity than they would be were they not confined in cages. To decide this point in the laboratory would entail very long research, whilst for obvious reasons it could not be put to the test in the field.

It seems probable, however, that there would be no danger to most of the coffee growers of the Central Province if *Metadrepana* were introduced there; nevertheless, the possibility of serious damage is not one to be dismissed lightly. There seems less reason to suppose that *Metadrepana* might not cause serious damage to coffee in the Rift Valley.

Biological Control.

In certain cases, where, owing to peculiar circumstances, no attempt to control a serious outbreak of leaf-eating caterpillar has been made, it has been found that areas of fifty to one hundred and fifty acres of coffee have been completely defoliated, after which the pest has disappeared completely, although there may have been more coffee available for further breeding. The cause of this sudden disappearance is almost certainly natural control by parasites and predators. The two most important of these are probably Hymenopterous egg parasites, and Rhynchota which suck the caterpillars, the most common of which is *Glypsus vigil*. The former, on account of their minute size, will probably not be seen in the field; the latter is a large "shield-bug" with striking red markings in the young stages and a dark greenish-brown coloration when mature. The following is a list of the known parasites and predators of *Metadrepana*:—

Parasites.

Tachinidæ—
- *Sturmia inconspicua* Mg.
- *Tricholyga sorbillans* Wied.

Ichneumonidæ—
- *Hemipimpla pulcher* Morley.
- *Xanthopimpla maculosa* Tosq.
- *Ichneumon* sp?

Braconidæ—
- *Aspilota* sp?

Chalcididæ—
- *Brachymeria bottegi* Masi.

Eulophidæ—
- *Euplectrus* sp?
- *Asympsiella* sp. n.
- *Pleurotropis* sp. n.
- *Tetrasticus* sp?

Predators.

Pentatomidæ—
Glypsus vigil Germ.
Vadimon sp?

Despite this list of parasites, the coffee planter should not assume that a great percentage of the caterpillars are parasitized, and that the outbreak will subside. Nor should he be afraid to use the control methods advocated in case he should kill useful parasites. All control methods for pests destroy useful parasites, but unless, as may happen in rare cases, the control exercises a selective action, killing more of the parasites than of the pest, its use should not be abandoned. The measures advocated do not do this. Although, if given time, the parasites will eventually control the pest, the damage the pest will do before this happens may be very great indeed.

Control.

In essence the control of *Metadrepana* is very simple. It consists in spraying the coffee bushes in the area affected, and also in the surrounding areas, with a stomach poison. The most easily obtained and most effective are made up as follows:—

Arsenate of lead (powder) ...	2½ lb.
Water	100 gallons.
Or	
Paris green	1 lb.
Air-slaked lime (or, better, dry water-slaked lime) ...	5 lb.
Water	200 gallons.

In mixing this latter spray, the paris green should first be made into a paste with a little water, then added to the lime, which is also mixed with water. The mixture should then be strained through a sieve into the main bulk of water.

Neither of these spray fluids is a solution, but a suspension of solid substances in water. The fluid must be kept well agitated whilst it is being sprayed. Either of these substances may be safely mixed with Bordeaux if this is desired.

Any good spraying apparatus may be used for application, from the small bucket pump to the large power sprayer. The point to remember, however, is that in an outbreak of *Metadrepana* time is all important. The best sprayer for the work is a large power sprayer; if small sprayers are to be used then a sufficient number should be available to spray at any rate ten acres a day.

The amount of fluid to apply varies with the size and state of foliage of the trees. The ideal to aim at is to wet every leaf, but not to allow the leaves to drip. When a drop forms at the tip of a leaf, surface tension collects the solid particles into this drop, so that the amount of actual insecticide lost in the drop is greater than is apparent. Careful supervision of the spraying will make a very considerable difference both to the quantities used and to the speed of application. Most planters and all natives tend to spray too heavily.

On average trees, 100 gallons of spray should be sufficient for 200 to 300 trees. A rough indication of costs may therefore be as follows:—

Cost per Acre of Spraying with Arsenate of Lead.

	Sh.	*cts.*
Arsenate of lead, 7½ lb. at Sh. 2/50 per lb.	18	75
Transport of water, 300 gallons	0	60
Labour	2	50
Depreciation on pumps ...	1	00
	Sh. 22	85

Cost per Acre of Spraying with Paris Green.

	Sh.	*cts.*
Paris green, 1½ lb.	1	80
Lime, 7½ lb.	2	00
Transport, labour and depreciation	4	10
	Sh. 7	90

In reducing this to the lowest possible figure, the planter should concentrate on watching the dosage per tree to see that there is no waste. The strength of the spray should not be reduced.

The paris green is sometimes liable to scorch, and care should be taken to avoid this by the use of adequate quantities of good quicklime, carefully slaked.

AFTER TREATMENT.

It often happens, though it should not be so, that the planter is caught unawares by an outbreak of *Metadrepana*, and some area of his coffee is completely defoliated. The treatment of these trees then becomes a serious problem. It seems to be the usual experience that such trees never bear a crop unless stumped and allowed to start afresh. It must be impressed upon planters, however, that trees which have been defoliated in this way must be regarded as being in a state of dieback, and should not be pruned or stumped until they have recovered. There is great risk that if they are stumped immediately, they will die.

There seems no real reason why a coffee tree should not recover from defoliation by *Metadrepana*, but very careful attention to pruning is required. It is probable that records of plantations which have been allowed to recover from *Metadrepana*, but have never borne a crop, are due to faulty pruning. The question has never been settled experimentally, however, and the Department would be grateful for information on the point.

To sum up, coffee planters west of the Rift Valley should know *Metadrepana* and its damage, and should always be on the lookout for it. Any caterpillar which they suspect to be *Metadrepana* should be packed with a few coffee leaves in a tin or box provided with holes, and forwarded to the Entomologist, Scott Laboratories, for identification. Stocks of paris green or arsenate of lead should always be available. No planter who looks after his *shamba* carefully should ever sustain any serious loss from *Metadrepana*. Control is simple, provided the outbreak is recognized early and immediate steps taken to combat it. Don't waste time trying to hand-pick the caterpillars, which is simply baling the ocean, but have your pumps and materials ready. If the attack is recognized in time, a very few acres need to be sprayed; if not, there may be little coffee left to spray!

The Department would be grateful to anyone who finds the caterpillar actually eating and breeding upon any indigenous plant. Such records are extremely valuable, but must be accompanied by the caterpillar and a good specimen, including if possible flowers, of the plant.

Notes on the Tung Oil Tree

By C. J. McGREGOR, *Dip. Agric., Dist. Agric. Officer, Tanganyika Territory.*

The notes set forth below are a summary of information collected on a visit to Florida and Southern Georgia, U.S.A., during 1934.

The seeds of the tung oil tree were introduced into the U.S.A. first in 1905 and in the period between that year and 1912 further introductions took place and experimental plantings were made in various areas of the Southern States. These plantings proved successful in some counties, with the result that today the acreage under tung oil trees is said to exceed 29,000 acres.

The tung oil tree belongs to the plant family Euphorbiaceæ. Its genus is *Aleurites* and species *fordii*. It is indigenous to Central and Western China. The tree is called tung oil, wood oil, tungshu, tung-yu shu. It is the only one of the genus *Aleurites* now being grown commercially in Florida. It is the hardiest of the genus, and will stand temperatures as low as 20° F.

The mu-oil tree is *Aleurites montana*. It is indigenous to Southern China but is said to be found together with *fordii* in some Chinese areas. This species is much less hardy than *fordii*, being damaged by temperatures that the latter will stand. On the other hand, it thrives in sandy soil, where it shows more vigorous growth than *fordii*. It should be noted that the damage done by frost to *montana* depends largely on the condition of dormancy at the time. Sudden cold spells are severely damaging. This species is not given much attention, as it is considered to be more suitable for more tropical climates, where temperatures in the winter season do not fall so low as in the Florida tung oil areas.

The tung oil tree is a beautiful tree with a large spreading habit. It grows to about 30 feet in height, and spreads to 15 to 30 feet. The leaves are large, dark green, and are lobed when the tree is young but on older trees are more heart-shaped. It is a deciduous tree. When twigs are broken they are seen to contain a milky juice, in common with the majority of the same plant family.

The blossoms appear before the leaves and are borne in clusters. They are white with a shade of pink at the bases of the petals. The tree is monoecious, each flower cluster being made up of one or more female flowers surrounded by numerous male flowers. The fruit is 2 to 3 inches in diameter, and is dark olive green, turning to brown on maturity. The fruits may be borne in clusters or singly. Each fruit has an outer husk. The seeds are 3 to 7 in number in each fruit, and are not unlike castor beans in shape. They are brown in colour outside, but are made up of a white, meaty, oily substance. The seeds contain violently purgative materials, and must not be eaten. On maturity the fruit falls from the tree, when it can be gathered.

The seeds do not remain viable for a long period, hence they are only planted in the season following their maturity. Hulled seeds deteriorate much more rapidly than those in the whole fruits. Germination usually takes 60 days, and averages about 60 per cent.

The common practice is to plant the seed in the nursery and to transplant the seedlings to their permanent positions when they are a year old and from 3 to 6 feet high. The system of planting at stake has been found to be too costly in Florida, especially as the germination percentage is often low. Ball planting is sometimes practised, and trees are also often pricked out into pots or tins at 3

inches high for easier and safer transporting later when they are ready for setting out. In general, however, the same methods are used in transplanting as with other fruit or nut trees. Trees several years old are transplanted successfully if the same care is exercised as for transplanting citrus, almonds, or any other fruit trees.

The fruit containing the seeds for planting is soaked in water until the hulls have softened, to facilitate splitting. The brown seeds are then set 2 to 4 inches deep in nursery rows, 2 to 3 feet apart, and 12 inches apart in the rows. Only hulled seeds are planted. Frequent cultivations are carried out, as for ordinary nursery stock. Applications of manure, nitrogenous fertilizers, and complete fertilizers are given with advantage.

The distance of planting is important. On Chinese experience of the size of the tree, 20 by 20 feet has been recommended, but it must be remembered that in China the trees are practically uncultivated and in consequence are smaller and yield less fruit. In the light of present information in Florida the distance of planting is recommended there to be 25 by 30, or 30 by 30 feet. Holing is done as for other fruit trees.

All malformed and undersized nursery trees are rigidly discarded in digging the nursery stock. Particular attention is paid to leaving the major portion of the taproot intact on the trees selected for planting. The time of transplanting is also very important. The trees should be planted when they are dormant. Records go to show that the transplanting of trees in foliage has always been followed by unsatisfactory growth.

Cultivation is very carefully carried out. Weeds are kept down, but any disturbance of the soil in close proximity to the tree is very shallow, as the tree is a surface feeder, and a mat of fibrous roots are just below the soil surface. These are on no account injured. Mulches are more advantageous than cultivation close to the tree when it is young. In old plantations the thick foliage and the spreading habit of the tree make cultivation unnecessary, and of course the spreading surface roots render soil disturbance undesirable.

In nursery stock there is a great variation in the height at which lateral branching commences. Some trees do not commence branching lower than 6 feet or more from the ground, with the result that later they become top-heavy. Further, it has been observed that such trees do not develop as soon as those with a lower branching habit. The method of pinching the terminal bud to promote branching has usually resulted in failure; in fact, pinching often has the opposite effect, causing the tree to throw out further vertical growth. In Florida it is therefore the practice to cut back the tree heavily when it is transplanted, and this usually promotes the desirable low branching habit; this in turn is stated to give greater yields because of greater twig capacity on sturdier limbs.

Another method of promoting branching consists of the removal of a strip of bark, 1/4 inch wide and 1 1/2 inches long, just above the bud at which a branch is desired. The operation is carried out after the dormant period, in spring. The wound heals and the branch thrown out at the bud below soon grows rapidly.

The pruning of older trees consists of removing dead wood and such branches as interfere with the convenient spacing of the wood.

Leguminous cover crops are planted between the trees with great benefit. The Crotalarias seem to be the most popular. In young trees cover crops are kept away from the trees, being confined to

the areas at least a few feet from each tree. Velvet beans and cowpeas are also used as cover crops with success.

In Florida the seeds fall in October and November as they mature. Gathering takes place when convenient, as the seed does not seem to deteriorate if left on the ground for a week or two. The whole fruit is marketed, as machinery now exists for separating the hulls.

The whole fruits, after thorough air drying, are first of all decorticated by a huller, during which process separation is also carried out. The huller not only removes the husk but also most of the hard seed coat. The separation of the seeds is carried out by a process of air suction. The seeds are then fed to a grinder by conveyers and thence into an expeller or press, which removes the oil by pressure, at the same time removing the residue. After settling, the oil is ready for marketing.

The plant of the Alachua Tung Oil Corporation, near Gainsville, was seen. This plant contains no new types of machinery for hulling and crushing, as it was found to be an easy matter, when the plant was installed, to adapt the machines that are used for such work in the production of other products. The capacity of the plant is about 50 lb. of oil per hour, and it was stated that this is adequate for several thousand acres of trees.

Plantings have been made on several soil types, but it is not yet possible to state which is the most successful, as the older plantings are confined to only a few types.

Tung oil trees are successful, however, on fine sandy loams that are well drained and moderately fertile. A system of mulching, cover cropping with summer legumes and winter legumes, in conjunction with liberal applications of fertilizer is proving successful and economical. The limiting factor with this tree, as with other surface feeders in sandy soil, appears to be nitrogen supply. Fertilizer trials, inaugurated in 1923 and continued since, clearly indicate this.

Tung oil trees definitely prefer a soil with an acid reaction, but to what degree it is acid tolerant has not yet been ascertained. Tests indicate that in soils of pH value above 7 the trees were definitely adversely affected by bronzing of the leaves, whilst normal growth was made in soil of pH 6.10. Excess of phosphate as well as lime has been shown to be detrimental to the growth of this tree. Organic manures have proved valuable.

It has been shown by workers with regard to bud differentiation that a season's crop from tung oil trees is dependent largely on the condition of thrift in the tree during the season prior to fruiting. It is inferred that soil fertility must be sufficiently maintained for the heavy crop and also for the vegetative growth for the following and later crops. The fertilizer is applied in two dressings—one in early spring and one when the tree is dormant. One reason for this is that the soil is sandy and losses by leaching are high.

Seed selection from known heavy bearers is followed rigidly in Florida. Experiments have shown some striking contrasts in yields of individual trees. The tung oil tree seems to maintain the prolific characteristic when propagated from seed in the same degree more or less as other fruit trees. Budding, however, has given good results. Propagation by cuttings has had no success. As the bark is so thick, patch budding and ring or annular budding have been the most successful. Budding is carried out in spring, as soon as the bark will slip easily. Buds are taken from the current season's growth. Care is exercised that "blind" buds are not taken.

Seedling trees vary considerably in fruitfulness. A test with ten trees over 18 years in Gainsville showed that two of the trees bore more fruit than the remaining eight together. Other tests have also proved this to be true. It has been shown also that unless the grove consists of prolific trees it may not be profitable. When a grove reaches maturity, top working of unfruitful trees with scions of fruitful ones is becoming the rule. If known heavy bearers are available top working is carried out much earlier.

There have been no varieties definitely separated as yet. An apparent varietal difference in the number of fruits borne on twig terminals has led to the tentatively named "single" and "cluster" varieties. Although the individual seeds from the "cluster" variety are lighter and smaller than those of the "single" variety, tests at Gainsville, Florida, for three years show the "cluster" variety to be the average heavier bearer.

100 lb. of fully matured and dried fruits consist of 56 lb. of seeds and 44 lb. of hulls. This gives 18 to 20 lb. of oil. One gallon of tung oil weighs 8 lb. Fruit from trees grown from unselected seed, under test, showed yields of from 60 lb. to 480 lb. of fruit per tree. Other individual trees have shown greater yields.

Mr. B. F. Williamson, of Gainsville, who is stated to be largely responsible for the founding of the tung oil industry in Florida, gives the following comparative figures: —

	Maximum Yield per Acre.
Cotton seed oil	150 lb.
Groundnut oil	300 lb.
Linseed oil	255 lb.
Tung oil (7-year-old) ...	1,200 lb.

He states that with selection, top working, cover crops, and adequate fertilizer he can see no reason why yields should not be raised in future years to 1,800 lb. per acre. He expects his own plantation to reach that figure. Other actual figures of yield on straight plantings of unselected trees on a commercial basis were placed at 820 lb. of oil per acre.

It appears that there are no diseases or insect pests of any seriousness on the tung oil tree in Florida. It is a host for scale insects, but ordinary spraying with the usual mixtures takes care of this.

Tung oil trees in the Southern Highlands have in the past proved unsuccessful. In spite of this, however, there are encouraging indications. I am convinced that the failures in the past were largely due to the fact that the trees were handled as forest trees. It may be possible to do that in the richer stretches to the north of the territory, but in this area it is certain that if the trees are to succeed they must be treated as delicate, heavy-yielding fruit trees, for that is undoubtedly what they are.

ACKNOWLEDGMENTS.

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Black Arm Disease in Uganda

By C. G. HANSFORD, *M.A., F.L.S., Mycologist, Uganda.*

HISTORY.

There are no certain records of the occurrence of this disease in Uganda before 1925, though there are strong grounds for assuming that it was present here for some few years before that date. In 1925 Snowden definitely identified it as present, and stated that it was of common occurrence. In the following year the leaf form of the disease was almost universal east of the Nile, and extremely common in Buganda; the stem form was common at Serere Plantation, following a severe hailstorm in September. In the following season the leaf spot form was practically universal, though the stem form was much less common than in the previous year. In 1928-29 the crop of parts of Teso District was severely attacked by both forms of the disease, and a very poor crop was obtained. The 1929-30 season is still referred to as the "Black Arm Year". In this season the disease was very severe in Teso, Bugwere and Lango, and in more limited areas in Busoga and Buganda. The loss of crop is estimated at from 50,000 to 70,000 bales of cotton, but in the light of later research it is difficult to estimate what proportion of this loss is directly attributable to the disease. In the following season the disease was much less severe. The seed supply for the areas severely affected during 1929-30 was obtained from the less severely attacked areas of Busoga. In spite of this change of seed, the leaf form of the disease was present in almost every plot shortly after germination, and gradually spread to every plant. The stem form was reported from many places, but never became severe, and in this season the disease had little effect on the crop. In 1931-32, in spite of prolonged wet weather in most parts of Uganda, the disease did not become epidemic nor important in its effect on production. The poor crop reaped in many areas was not due to the attack of disease but rather to excessive shedding caused by the wet weather. In 1932-33 the damage due to the disease was comparatively slight, except in Usuku and Kumi areas of Teso District. In 1933-34 the situation was much the same as in the previous year. In 1934-35 season, infection was earlier and more serious, especially in Teso and parts of Lango and Bugwere Districts; the crop was very low in these areas.

SYMPTOMS.

The disease first appears on the leaves of the plant, and shows as small, water-soaked spots, limited by the network of veins of the leaf, and angular in consequence. As the spots become older they gradually turn dark brown, and eventually dry out. The spots may be scattered more or less uniformly over the leaf surface, in which case the damage is comparatively negligible, or may be concentrated in lines along the four or five main veins of the leaf. In the latter case there is grave danger of the infection spreading to the stem through the petiole of the leaf. This spread of the bacteria through the leaf stalk is the origin of practically the whole of the stem infection observed.

On the stems, the infection in most cases commences at the junction of the leaf stalk with the stem or branch, and thence, under suitable climatic conditions, spreads longitudinally through the stem tissues, but chiefly downwards. Upon the number and extent of these lesions, and the date of infection in relation to the sowing date of the cotton, depends the damage caused by the dis-

case to the crop. If infection takes place at an early stage in the development of the plant, on its main stem, the whole of the tissues above the point of infection may be killed; if the plant is able to make any recovery, it forms new branches below the infection. Damage by such early infection may have a great effect upon the development of the crop and influence the whole appearance of the plants throughout the season.

On the bolls, infection results in roughly circular spots, of a water-soaked appearance at first, later turning dark purplish-brown, and drying out. If the boll is very young when infected, the whole boll may be shed, or it may remain on the plant and develop one or more semi-normal locks, the others being completely rotten.

If older bolls are infected, the damage depends upon the extent to which the bacteria are able to develop in the tissues; they may remain limited to the tissues of the boll wall, or may penetrate into the lint cavities and either stain or rot the contents. In any case, infected bolls tend to open prematurely, owing to the drying out of the lesions as they become senescent, and the tissues contract, forcing the opening of the boll, with consequent damage to the lint inside.

Effect of Climatic Factors.

A large amount of work has been done on this aspect of the disease in Uganda during recent years, and present views may be summarized as follows:—

The disease definitely spreads during heavy rainstorms, and the direction and extent of such spread from plant to plant is the resultant of two distinct factors, which may act to supplement each other or may be in direct opposition. These are the direction of the rainstorm and accompanying winds, and the direction of the flow of surface water during the storm. Of these, the second is the more important in spreading the disease. The surface water is infected with the bacteria from diseased leaves, and is splashed up by the rain on to healthy plants. If the storm is very heavy little infection may result; presumably the net result of such storms is to wash the bacteria off the plants before infection can take place.

During periods of cool moist weather there is grave danger that infection may spread from the infected leaves through the petioles into the stem tissues. The infection on the leaves is unimportant, and negligible in its effect upon the crop production of the plants, except in so far as it leads to stem and boll infection. The spread of the bacteria through the tissues of the leaf stalk may be considered as a race between the growth of the bacteria, and efforts on the part of the plant to limit this, or to avoid stem infection by shedding the infected leaf and stalk. In consequence, any climatic or other factors assisting the plant to make rapid and steady growth will assist it in getting rid of the infected tissues before infection of the stem can take place. Thus a few days of fairly hot, dry weather will enable the plant to do this, and stem infection becomes reduced to a minimum in spite of the prevalent leaf infection. On the other hand, continued cool moist weather assists the growth of the bacteria through the tissues of the leaf stalk, as these are full of water, and the plant appears unable to shed the leaf as rapidly.

While the above views are supported by many observations in the field and with experimental evidence, the effect of alternating periods of wet and dry weather is much more complicated, and the balance between the plant and the invading bacteria is very delicate. In some instances such alternating periods may control stem infection to a large extent, but in others similar conditions have definitely resulted in very heavy incidence of stem infection or "black arm". In spite of the accumulation of data on this problem, its elucidation seems as far removed as ever.

It will be gathered from the foregoing remarks that we have not yet reached the stage at which we can forecast the effect of any given climatic conditions on the damage to the crop by this disease. Present indications are that a season of

alternating periods of dry and wet weather usually results in a bad attack of the disease; this effect may be due partly to the repeated shocks to the growth of the plants in such a season, and partly to the direct influence of such conditions on the spread of the leaf form of the disease and its growth through the leaf stalks into the stem and branches.

Relation to Insect Pests.

At one time it was considered possible that the disease might be actually spread by such insects as Jassids, but experiments recently conducted give no support to this view. The only correlation obtained has been with *Lygus*, which causes damage to the leaves of the plants. The edges of the holes caused by this insect in the leaves are often found to be infected with the leaf spot due to this disease; no relation between insects and the stem form of the disease has yet been discovered in Uganda.

Perpetuation from Season to Season.

The bacterium causing the disease is carried on the seed of the crop through the close season, and infection of the young plants takes place during the germination period. Most of this seed-borne infection is carried in the fuzz and hairs on the outside of the seed, and can be controlled by delinting the seed with sulphuric acid, as is done in the U.S.A., where the acid is cheap; or by the use of fungicidal dusts, as is the practice in the Sudan. The use of sulphuric acid in Uganda is too expensive a measure to adopt, and there are certain risks to be taken if the seed for native use is to be treated with poisonous dusts. Hitherto, these treatments have not been applied generally in Uganda for the reasons given.

Not only is the organism carried on the outside of the seed, but it is known that some seed is infected internally, and such infection cannot be controlled by any use of fungicides. This internal infection is usually rare, often only 1 in 10,000 seed, though odd cases have occurred in which this infection is of the order of 1 per cent.

In the Sudan, where all seed has been dusted for some years now, it has been determined that the greater part of the infection now occurring is due to the spread of the disease from old plants and volunteer plants growing in the land used for the previous crop, and adjoining the new fields. In Uganda this source of the disease is less important, as in many areas where the disease is of most common occurrence the old crop is followed by Eleusine (*bulo*), grown for food. During the weeding of this, all cotton plants are eradicated, and this occurs before the new crop is planted. Infection from debris remaining in the soil is very doubtful under Uganda conditions, as the new crop is very rarely grown on land used for the previous one unless a crop of Eleusine has been grown in the interval. The early plantings of cotton in Uganda are always made on freshly opened land, as the land used for the previous crop of cotton is sown with various food crops immediately after the removal of the cotton and often before this takes place. The only experiment on this point made at Serere in 1933 indicated that infection from debris in the soil did not take place to any marked extent. No difference in initial infection on young seedlings occurred between plots of freshly opened land, on some of which large amounts of infected material from the previous crop had been dug in before sowing.

Effect on the Plant.

Large numbers of detailed observations have been made on this point, with the result that the effect of infection is

found to be the result of the following factors:—

(*a*) The site of the lesions on the plant.
(*b*) The age of the plant when infection occurred.
(*c*) Climatic conditions.
(*d*) Soil conditions, in so far as they affect the general growth and health of the plant.
(*e*) The number of lesions in relation to the size of the plant.

In the case of the cotton variety S.G.29, which is the present standard variety over large areas in Uganda, infection on the large basal branches (monopodia) at an early stage results in the death of one or more of these and consequent great loss of crop.

When infection occurs on very young seedlings a large number of deaths results, or, if the plants have passed this stage, many suffer severely. In young stems and branches the lesions develop very rapidly, and often cause the death of all tissues beyond the lesions.

Evidence has been accumulated indicating that plants growing on the lighter soils of Uganda are more liable to severe attack of Black Arm than plants growing on the heavy red clay soils. This may be in part due to climatic factors, which often favour the development of the disease in the same areas. Under climatic conditions favouring recovery of the plant from attack, plants growing on poor patches of land are certainly less able to make complete recovery than those on good soil.

When plants with stem lesions are exposed to dry, hot conditions, the lesions tend to dry out completely, and are thrown off as part of the bark of the plants. Such lesions have no further effect upon the plant, and do not as a rule re-enlarge under a return of moist weather.

While the above remarks are largely the result of detailed observations in the field over some four seasons, it has proved a very difficult matter to obtain direct evidence in support of them from plot experiments in which the data are treated statistically. It appears that the yield of such plot experiments is the result of so many different factors, of which disease is only one, that it has been impossible to separate them and obtain evidence of the nature required.

Varietal Resistance.

During recent years considerable attention has been devoted to this, with the result that at the moment a number of varieties have been isolated, chiefly from the South African U4. strain of cotton, which show marked resistance to infection by this disease. It has been determined that this resistance is the sum of at least two separate factors:—

(*a*) Actual resistance to leaf infection.
(*b*) Resistance to the development of the stem form of the disease, even when the leaves are infected.

Thus we have some strains at present which during whole seasons show very little leaf infection, and others which, though they show practically as much leaf infection as S.G.29, which has always been used as a control in this work, yet rarely become infected in the stem and branches. The leaf form of the disease is negligible in its effect on yield, so that the latter class of varieties is, in its resistance to stem infection, just as valuable as the former, which does not even become infected to any large extent on the leaves. Though resistance to the disease is inherited by the progeny of resistant plants, this inheritance is not universal, and at any time it is possible to select strains from resistant parents which are much more susceptible. Constant care has to be exercised every year in this matter.

Observations on Coffee under Artificial Shade at Selian Coffee Estate, Arusha, 1931-35

By D. STURDY, *M.A., District Agricultural Officer, Tanganyika Territory.*

Severe dieback of coffee (*Coffea arabica*) in 1930 in the Engare ol Motonyi basin, one of the principal coffee-growing areas in the Arusha District, Tanganyika Territory, led the Department of Agriculture in 1931 to commence a series of trials on an estate in that area, with the object of obtaining some indication of the causes of dieback by observation of a large number of trees subjected to different treatment.

Among the treatments suggested for trial by the Director of Agriculture (Mr. E. Harrison) was one using artificial shade, planned on the lines of some existing shade of this type erected by the Kenya Department of Agriculture at the Scott Laboratories, Nairobi. Mr. G. Bloom kindly put at my disposal an area of two-year-old coffee trees, at the time bearing a small first crop of green cherry, and artificial shade of three intensities was erected over six rows of these trees in March, 1931. The results obtained in this shade trial have been more significant than those obtained from any of the other trials undertaken at the same time, and are thought to be of some general interest.

METHODS AND MATERIAL.

The two-year-old coffee trees used in this trial had been unaffected by the dieback of the previous year, as they were not then in bearing. Triangular planting allowed of parallel rows being obtained, which were very nearly east and west, this direction being necessary to get an even distribution of the shade throughout the day. Rows of sixteen trees were chosen, and the treatment for each of these rows—lettered G to W, progressing from south to north—was as follows: —

G.—No treatment.
H.—No treatment.
I.—Some winter shade from that over Row J.
J.—Light shade of bamboo laths 4 ft. by 3 ft. 8 in. over each tree, about 6 ft. 6 in. above the ground level.
K.—Some summer shade from that over Row J.
L.—No treatment.
M.—Winter shade from that over Row N.
N.—Continuous strip shade, about 8 ft. wide over the whole row. (Medium intensity.)
O.—Summer shade from that over Row N.
P.—No treatment.
Q.—Winter shade from that over Rows R, S, etc.
R., S., T., U.—Continuous shade the full width from the outside of Row R to the middle of Row U, and covering the full length of the rows. (To represent shade of heavy intensity.)
V.—Summer shade from that over Rows U, T, etc.
W.—No treatment.

Time being a limiting factor in the number of trees which could be closely observed, not every row could be given the same amount of attention, but Rows G and W were taken as controls (unshaded), and with Rows J (light shade), N (medium shade) and S (heavy shade), were closely recorded for symptoms of "yellowing" and "dieback" at approximately fortnightly intervals throughout 1931 and at rarer intervals during 1932 and 1933. More occasional observations were made on trees in the other rows, particularly Rows M and Q (winter, or June, shade), and Rows O and V (summer, or December, shade).

In making the above observations, points were marked against individual trees to record the degree of "yellowing"; any definite "yellowing" of the leaf, with usually some slight deformity, was counted as a full point, while the more common paling of the leaf-tip and loss of chlorophyll along the edges of the leaves as a half or quarter point.

In addition to the above observations, actual weights of cherry harvested have been kept throughout the period 1931-1934; an attempt has been made to record the differences in growth resulting from the shading, and other factors, including resistance to pests and diseases, size of bean, and liquoring quality, have been given consideration.

TABLE I

POINTS RECORDED FOR YELLOWING IN UNSHADED AND SHADED COFFEE, APRIL, 1931–APRIL, 1932

MONTH	Unshaded	Shaded
1931 :		
April	10	1
May	13	2
June	14½	3
July	15½	1
August	14½	1
September	10½	0
October	6	0
November	1	0
December	0	0
1932 :		
January	0	0
February	¾	0
March	3¾	1
April	14	0

RESULTS OF OBSERVATIONS ON CONTROL OF "YELLOWING" BY SHADE.

The observations carried out during 1931, 1932 and 1933 show conclusively that yellowing commences during the hot season before the onset of the long rains, and that it gradually increases in intensity during the rains and the subsequent cold season. A peak point is reached in July-August, i.e. at the height of the cropping season, after which, with the commencement of the warmer weather in August-September, and the rapid harvesting of the crop, the intensity of the yellowing quickly decreases, until by November, when all the crop has been harvested, trees which merely yellowed have regained a normal colouring. This seasonal variation is plainly illustrated by taking the period of the first thirteen months after the commencement of the trial, as in Table I.

Reference to Table I also shows that artificial shade erected in March, 1931, prevented any considerable increase of yellowing and permitted an early recovery of the affected trees. Subsequent years have shown that artificial shade almost completely controls yellowing and also dieback, which is taken only to be a more serious form of the same trouble.

If yellowing has progressed as far as the condition known as dieback, then there is no, or very little, recovery after the crop has been harvested, and the tree may remain in a yellow unhealthy condition for several seasons. Certain trees which died back in 1933 are still showing this condition in April, 1935, though some appear to be making a slow recovery. It has to be understood therefore that severe yellowing and the condition known as dieback cause considerable reduction in crop over a number of years. It is claimed that artificial shade much reduces these losses.

Table IIa shows the trees in Rows G and W (unshaded) and N and S (shaded) which suffered from severe yellowing and/or dieback in each year; and Table IIb shows the trees in these rows which failed to crop in a following season.

During the four years of the trial, 1933 was the season in which the largest

TABLE IIA

TREES WHICH SHOWED SEVERE YELLOWING AND/OR DIEBACK

	1931	1932	1933	1934
32 TREES :				
Unshaded ..	6	6	21	13*
Shaded ..	1	2	3	2

*Many of these trees were casualties remaining over from the 1933 crop.

TABLE IIB

TREES WHICH FAILED TO CROP IN A FOLLOWING SEASON

	1932	1933	1934
32 TREES :			
Unshaded	0	2	23
Shaded	1	1	12

crop was harvested (*see* Table IV below); as was to be expected, it was also the season in which there were most casualties from yellowing and dieback. While, however, the likelihood of severe yellowing is increased when there is a heavy crop, it cannot be said that because a tree has a heavy crop it will inevitably suffer, since some trees die back with a much lighter crop than others.

RESULTS OF GROWTH MEASUREMENTS.

In late 1932 it was obvious, from casual observation, that the artificial shade was altering the habit of growth of the trees submitted to this treatment, and accordingly an attempt was made to measure this for record purposes. The trees had all been capped in 1930, about six months prior to the erection of the shade, and it seemed that it would be convenient to measure the new growth from this point. It being impossible to measure all the trees, Rows W and S were chosen to represent respectively unshaded and fully shaded trees. The following means were then adopted to get comparable measurements:—

Main Stem Growth.—The total growth made subsequent to the capping was measured for each tree, and divided by the number of nodes; the average of the sixteen trees in each row was thus found.

Branch Growth.—The total length of the first primary and its secondaries, etc., on the south-east side of the tree above the capping was measured, and again divided by the number of nodes, and an average for each row again obtained in this manner.

Leafage.—At the same time, it was decided to make an attempt at obtaining the leaf area of these same trees. This was done by counting the total number of leaves on the same branches as were used for the measurements above, and also by taking representative leaves and measuring the maximum length and breadth, thus obtaining an average leaf size for each tree and an average number of leaves for each tree.

The results of these measurements are given in Table III, and indicate the manner of change in the build-up of the trees resulting from shade.

TABLE III

CHANGE IN TREE FORM DUE TO HEAVY SHADE

	Unshaded	Shaded	Percentage Increase
	Inches	*Inches*	*Per cent*
Average main stem internodal length ..	2·44	3·00	22·9
Average branch internodal length ..	1·20	1·46	21·6
Total number of leaves per branch ..	236	162	—31·4
	Sq. ins.	*Sq. ins.*	
Average area of any one leaf ..	3·25	5·96	83·3
Total leaf area per branch ..	767	965	20·5

Pest and Disease Incidence Affected by Shade.

Two observations have been made with regard to the effect of shade on the severity of pest and disease attack. In November, 1931, when the whole area upon which the various trials were being conducted was very badly attacked by the coffee thrips (*Physothrips xanthoceros* Hood), shaded coffee appeared to suffer less from defoliation caused by thrips than did unshaded coffee. Thrips is by far the most serious insect pest of coffee foliage experienced in this district, and unless adequately controlled by spraying causes serious defoliation.

The second observation was made by Mr. Edwards, who records that in 1933 *Hemileia vastatrix* (the coffee leaf disease) attacked coffee trees under the artificial shade more severely than the coffee trees under partial shade, and that these in turn were more severely attacked than unshaded coffee; at the same time it is recorded that the attack was mild, even under the heavy shade.

Crop Records: Shaded *versus* Unshaded Coffee.

The whole crop of ripe cherry has been measured each season from each tree individually, and while, owing to the great variations in individual tree "capacity" and the unscientific layout of the experiment, I make no claim that the results will stand statistical examination, or that they provide any real proof that over a number of years shade will increase crop, yet they are considered of sufficient interest to be recorded, and are accordingly given in Table IV.

While picking cherry at various times, both in the open and under shade, an attempt has been made to ascertain the number of cherries weighing a given weight, as an indication of the size of the bean. From the field records, I find that, varying to a considerable extent with each season and also at various dates within any single season, unshaded cherry has weighed between 20 and 25 cherries to the ounce (in some cases as high as 30 in 1934, which was a season of particularly dry weather and small, juiceless cherry), and that shaded coffee cherries have varied between 18 and 20 to the ounce. It would appear from this, and also from the condition of the cherry, that shading produces a juicier cherry and possibly a larger bean.

TABLE IV

Average Cherry Weight Harvested per Tree, in Each Row, for Each of Four Years. In Ounces

Row	Weight				
	1931	1932	1933	1934	Total
G ..	31·2	23·2	129·5	3·3	187·2
H ..	31·3	29·5	91·3	6·6	158·7
I	23·5	37·7	98·9	6·1	166·2
J	21·6	21·3	95·0	18·0	155·9
K ..	21·9	34·5	104·0	9·0	169·4
L ..	35·0	31·9	90·2	3·4	160·5
M ..	23·5	15·8	107·4	2·4	149·1
N ..	31·1	36·3	123·8	12·0	203·5
O ..	17·8	32·4	128·9	7·8	186·9
P ..	25·9	33·6	110·6	4·3	174·4
Q ..	31·8	30·0	115·0	1·9	178·7
R ..	26·4	19·8	159·9	1·9	208·0
S ..	31·1	16·8	155·6	6·6	210·1
T ..	25·5	28·7	158·3	2·7	215·2
U ..	18·0	35·0	132·6	13·3	198·9
V ..	22·6	46·2	67·7	9·0	145·5
W ..	25·6	26·8	110·0	0·7	163·1

In 1933 samples of shaded and unshaded coffee were prepared separately and sent to London for report; and from the reports received from the broker to whom they were submitted there appears to be a slight advantage in favour of the samples from beneath the artificial shade. An extract from this report is given:—

Mid-Season Unshaded

Parchment .. Golden bright.
Cleaned .. Smooth.
Roast .. .. Good, too many ears.
Liquor .. Quite good.

MID-SEASON SHADED

Parchment	Golden bright.
Cleaned	Very bold. Bright.
Roast	Very good.
Liquor	Quite good.

LATE UNSHADED

Parchment	Reddish.
Cleaned	Foxy, rough. Small.
Roast	Fair mixed pales.
Liquor	Sour, overfermented.

LATE SHADED

Parchment	Reddish.
Cleaned	Bolder, Greenish, reddish.
Roast	Fair, open.
Liquor	Sour, overfermented.

NOTE.—Both the late season samples were overfermented.

DISCUSSION.

The object of the trials here reported upon has been observation, not experimentation; the results, with the exception of the crop weights, are fairly clearly defined, and generally indicate a considerable advantage to be obtained by the use of artificial shade. It is necessary to state that the artificial shade used was far too expensive to be of practical value.

Yellowing and dieback have been controlled to a very great extent by the use of artificial shade, and, since trees which experience severe yellowing are unlikely to bear in the following year or even for a longer period, it is not improbable that over a series of years increased crop may be expected from trees under artificial shade.

Considerable differences in the amount of leaf and of the leaf area of shaded and unshaded trees are recorded, but there is no data to show if this accounts or in any way explains the reduction of yellowing. A consideration of the effect of shade on the principal leaf pest and leaf disease was considered necessary, but the observations recorded are of a single outbreak of each only; however, since they bear out the practical man's ideas, they may be taken as satisfactorily conclusive.

In all experiments with coffee it is important to consider any possible effect which the treatment may have on the general quality of the product. In this case there seem good grounds for supposing that artificial shade will produce a bigger bean, which is a slight advantage; but there are no indications that there will be any alteration in the liquoring quality.

ACKNOWLEDGMENTS.

I have to acknowledge the work done by Mr. L. C. Edwards, Dip.Hort.R.H.S., in maintaining the records during my absence on leave from January to September, 1933, and to all other members of the Department of Agriculture who have contributed advice and suggestions in carrying out these observations. Particularly my thanks are due to Mr. Goodall Bloom, of the Selian Coffee Estate, Arusha, who permitted the carrying out of this and other trials upon his land.

Mulching with Grass and Plantain Trash and its effect on crop and soil conditions

By W. S. MARTIN, *M.Sc., Ph.D., A.R.C.S., D.I.C., A.I.C.,*
Agricultural Chemist, Uganda.

INTRODUCTION.

In 1925, after a decade of clean weeding in permanent crops in Uganda, it became evident that the practice had very grave disadvantages under Uganda conditions. All too frequently, erosion was severe and the soil was "dead", having lost all its organic matter. Coffee yields were on the average very low, and areas which did set a big crop invariably suffered from dieback, associated with *Hemileia,* and failed to ripen all the crop. As a result, the Department called attention to the dangers of clean weeding on account of the erosion which was taking place, and an artificial mulch was advocated.

THE SOIL MULCH.

The basic idea behind the practice of mulching was one of conservation of moisture, the original and most widely advocated mulch being what was known as a dust mulch. This is a misnomer, because all that is intended is that the soil shall be cultivated after each rain to break the capillaries and prevent undue evaporation from the surface. Experiments were made to prove this, and the soil mulch became a standard practice under dry-farming conditions. In fact, the aim of the clean weeding programme in plantation practice was the production of a soil mulch which, by reducing weed competition and direct evaporation, undoubtedly does conserve moisture, but Keen, Shaw and others have shown that there can be no capillary rise of water to take the place of that used by the crop unless the water table is within six feet of the surface.

Continual cultivation is needed to keep a soil mulch intact, with the result that the soil of the mulched layer is never used by the roots. The top six inches of soil is normally the most fertile, and under mulching conditions is not available. The continual cultivation also means loss of humus, particularly under tropical conditions, and loss of humus invariably means loss of texture and water-holding capacity. Under tropical conditions, too, the maintenance of a light loose top layer of soil is very expensive, and serious erosion must follow.

ARTIFICIAL MULCHES.

Artificial mulches are formed by the application of straw, chaff, peat, leaves, sawdust, stones, or other material on the surface of the land. Most authorities on soils dismiss this method, because of the expense attached and labour involved, but admit that such mulches are very effective. In calculating the costs they seem to have omitted the tremendous and continuous expense attached to the upkeep of a soil mulch, which should be deducted from the gross cost of an artificial mulch. Very little scientific work on artificial mulches has been carried out, but the following records are interesting.

An experiment at Cornell University to estimate *The Cause of Injury to Maize by Weeds* by Craig in 1908 included a straw mulch treatment, and the results were: —

TABLE I

Treatment	Yields calculated to basis of 100 on controls	Soil moisture per cent during August
		Per cent
Control	100	21·1
Weeds removed but not cultivated	96	18·2
Mulched with straw ..	121	25·0
Control	100	18·2
No cultivation weeds allowed to grow ..	31	9·8
One cultivation weed allowed to grow ..	98	17·0
Control	100	17·7

Here the mulched plot gave an increase of 21 per cent in yield, and an increase of more than 5 per cent moisture on the mean control. Unfortunately, there were only single plots of the treatments, and the work was not followed up. Albrecht, publishing in 1922 and 1925, working solely on the nitrate and moisture effects of straw mulching, reported a decrease in nitrates and an increase in moisture under a straw mulch. He also noted that the soil under a mulch became plastic, sticky, and of poor tilth, and suggested that the lower nitrate formation was due to lack of aeration, low temperature and too much moisture.

Beaumont and others published in 1927 and 1933 an experiment on straw mulching in orchards, in which the first samplings after the mulch application showed a decrease in nitrate, but after three years of continuous mulching the nitrates increased over the control. This was explained on the C/N ratio of the lower layers of mulch. No mention is made of yields or of any change in soil texture in this case.

In 1914, in Hawaii, on a sugar plantation, a light tarred or asphalted paper was spread directly over the rows of seed cane and harvested stubble as a measure of weed control. In the middle of the rows, between the sheets of paper, cane trash was used as a mulch. No yield records are available, but the advantages of the practice were so obvious that it was extended to pineapple production. Here records were kept of moisture, temperature, and nitrate content of the soil, all of which showed an increase as a result of mulching.

The value of a mulch as an anti-erosion measure is self-evident from a purely mechanical standpoint, but experiments by Lowdermilk, of the Forestry Research Station, California, have led to an interesting theory which fits the facts. The suggestion is that the force of the rain on reaching the soil is sufficient to detach the clay particles, so that the liquid percolating is muddy and tends to clog the soil pores. To prove this he percolated ordinary soil first with clear water and then with muddy water. The result was a 90 per cent diminution in percolation within six hours of using the muddy water, and the drainage water was still clear. On reverting to clear water the percolation rate did not improve. Anyone who has seen puddles during rain on cleared land must have noticed that the water is muddy and the fact that muddy water reduces percolation and enhances the possibility of run-off is proved. Any sort of artificial mulch will protect the surface soil from the force of the rain and reduce the chances of a muddy percolating liquid.

Trials in Uganda.

Permanent Crops.

The main objection to mulching on European estates is the cost. This varies with the density of the grass cut and the distance it has to be carried. Plantation

costs have varied between Sh. 10 and Sh. 60 per acre. In a few instances, where lorries were used, the costs were over Sh. 100 per acre. To attempt to put the question on an economic basis, an elaborate 8 x 8 latin square experiment was laid down on Mr. Stafford's estate at Hoima. The treatments were:—

		Per acre
A.	Sulphate of potash	2 cwts.
B.	Superphosphate	2 cwts.
C.	Control	—
D.	Diammonphos	180 lb.
	Sulphate of potash	2 cwts.
E.	Superphosphate	2 cwts.
	Sulphate of potash	2 cwts.
F.	Diammonphos	180 lb.
G.	Cotton seed	3 tons
H.	Elephant grass mulch.. ..	12" deep

TABLE II

THE EFFECT OF MULCHING AS COMPARED WITH VARIOUS FERTILIZERS

TREATMENT	YIELDS OF CHERRY IN CWTS PER ACRE									
	A	B	C	D	E	F	G	H	Mean	Significant difference
Yield	3·61	6·1	3·27	7·0	5·92	6·08	6·65	18·1	7·09	4·14
Percentage of mean	51·0	86·1	46·1	98·8	83·5	85·8	93·8	255·3	100	58·5

Here the mulch gave more than double the yield of either cotton seed or Treatment D—a complete, easily soluble, artificial manure, so that the mulch can bear at least twice the cost of application of any other fertilizer. The actual difference between the mean mulch yield and the mean control is 2.3 cwt. of clean coffee, which at Sh. 40 per cwt. on the estate amounts to Sh. 92, and on this estate the mulch cost was Sh. 63 per acre—a net gain of Sh. 29 per acre, without deducting weeding costs from that of the mulch.

An experiment was laid down at the Government station at Bugusege in 1928 on a 5 x 5 latin square with the following treatments:—

A.—Clean weeding.
B.—Green manure (two crops a year).
C.—Banana leaf mulch.
D.—Weed cover.
E.—October to March cover.

The results to date show the treatments A and C are significantly better than the others, whilst treatment E is better than B and D. The picking season of C is longer than that of the other treatments, but 80 per cent of its crop was picked within a period of one month.

There are indications that mulching is giving a more even annual crop, as opposed to the big fluctuations normally met in Uganda.

A combined field and laboratory experiment is being carried out to test the effects of various ground treatments on

TABLE III

EFFECT OF GROUND TREATMENT ON THE YIELD OF COFFEE

	YIELDS IN LB. OF CHERRY					
	1930	1931	1932	1933	1934	Total
A ..	190	408	3,731	2,789	1,512	8,630
B ..	184	315	3,713	1,702	1,202	7,116
C ..	168	390	4,211	1,988	1,760	8,517
D ..	205	255	2,844	1,909	558	5,771
E ..	192	405	4,465	2,290	493	7,845

soil moisture, temperature, and nitrate content. The treatments are: (*a*) Clean weeded; (*b*) Cover crop (*Centrosema pubescens*); (*c*) Weeds slashed; (*d*) Mulch. The experiment has been running for nearly two years, and it is definite that the soil moisture under a mulch is much higher than the other treatments, and the temperature lower. For the first year of its growth the cover crop plot was the driest, but afterwards it recovered, and at the time of writing it is almost as moist as the soil under mulch. Nitrates under mulch and cover crop are both lower than in the clean weeded plot. There are also indications that some soil types under mulch tend to become sticky and plastic, as recorded by Albrecht. Up to the present there is no acidity change, and the most probable explanation is that under a mulch a soil is not exposed to alternate wet and dry periods, which help to preserve the texture of heavy soils in the tropics. To combat this tendency, and to reduce mulching costs, alternate row alternate year mulching was tried at Hoima.

TABLE IV

COMPARISON OF COMPLETE AND ALTERNATE ROW MULCH

TREATMENT	Mean yields of Cherry in cwts. per Acre		
	1933	1934	Mean 1933 and 1934
Complete mulch (long grass)	9·2	21·0	15·1
Alternate row mulch (chaffed grass) ..	4·8	11·7	8·24
Control	4·0	11·2	7·57
Complete mulch (chaffed grass)	5·4	15·7	10·53
Alternate row mulch (long grass)	6·0	18·5	12·25
Significant difference..	2·7	6·7	3·79

From these figures it is evident that there is no necessity to go to the expense of chaffing grass, and the complete mulch is not significantly better than alternate row mulch, which can be applied at half the expense and will help the soil to regain texture.

To test the effect of mulch together with other treatments on young coffee an experiment was laid down at Lukumbi, with the following results:—

TABLE V

GROUND TREATMENT AND MANURING ON YOUNG COFFEE

TREATMENT	Mean yields of Cherry in cwts. per Acre		
	1933	1934	Mean 1933 and 1934
Cotton seed (3 tons per acre)	17·00	50·43	33·71
Control	11·97	39·30	25·63
Meraco bone meal (10 cwts. per acre) ..	17·12	43·71	30·42
Green manure ..	13·02	38·45	25·74
Mulch	15·60	51·11	33·35
Nicephos (240 lb. per acre)	15·63	48·10	31·86
Significant difference..	4·18	7·83	2·11

In this case there was no significant difference in yield between mulch and the two manuring treatments, but the difference in the appearance of the trees was remarkable, in that the trees of the mulched plots carried their crop well and the other plots all showed the typical signs of overbearing.

PRACTICAL APPLICATION IN UGANDA.

It is evident, both from the results of the experiments already given and from actual observation in the field, that, as far as Uganda is concerned, mulching is

the best treatment for coffee yet discovered. This is particularly true in native agriculture, as with scattered native plots the cost of the mulch is practically nil. The native Arabica coffee-growing industry in Bugishu was in a very poor state in 1930, but after mulching was adopted the industry reached a sound position.

In Buganda, where the main native coffee crop is Robusta, mulching is also being encouraged, and in the drier areas the policy has been to establish coffee only where grass is available for mulching.

On plantations, the difficulties of mulching are twofold—the availability of mulching material and the cost of application. Both difficulties are solved to a certain extent by the alternate row mulch, which enables a bigger area to be treated with the material available and at the same time halves the cost. By adopting this policy and by reducing the depth of the mulch one planter has been able to cover over three hundred acres, at a cost of little more than Sh. 10 per acre. Areas in which coffee production would have ceased to be economical through loss of vitality in the trees and soil erosion now produce a paying crop. Many aspects of mulching still require further investigation, such as the optimum time of mulching and the effect of mulch on soil texture. The solution of these problems is a local one, depending entirely on climatic conditions and soil type.

ACKNOWLEDGMENTS.

The writer is indebted to Messrs. D. N. Stafford and L. J. Jarvis for carrying out experiments, and to Mr. C. G. Hansford for the statistical analyses of the yields.

A Parasitic Weed of Sorghums

(*Rhamphicarpa veronicæfolio* Vatke)

By N. R. FUGGLES-COUCHMAN, *B.Sc. (Lond.), Dip. Agric. (Cantab.), A.I.C.T.A., Tanganyika Territory.*

During 1933 attention was attracted to the fields of cut sorghum round Kilosa by the floral picture which they presented. In two areas such fields were a blaze of magenta flowers. On inspection it was found that most of the flowering plants were in close proximity to the sorghum stumps, and a careful digging up of several roots showed definite attachment of the roots of the flowers to those of the sorghums. Plants were sent to Amani for identification, and it was found to be *Rhamphicarpa veronicæfolia* Vatke (Scrophulariaceæ).

Within the district of Kilosa the plant appears widespread, but has only been noted in great profusion growing on black, light alluvial soils in two or three areas near to Kilosa Township. It has not been noted from red soils, but may occur on them. It was known to the natives as an "enemy" or "sickness" of sorghum, and is called locally *lalizi,* as opposed to the two varieties of Striga which are known as *saani,* and which occur in conjunction with it.

The plants commence to appear under the sorghum in April, when the latter is beginning to flower. Plants increase rapidly in numbers until, in July, when the sorghums are usually cut for harvest, the fields show up as a magenta sheet. In this *Rhamphicarpa* is rather later than Striga, which is most abundant earlier in the year.

Rhamphicarpa plants are 18 in. to 30 in. in height, having mostly opposite sessile leaves, which are lanceolate and serrate. The stems are hirsute and much branched. The pale magenta flowers are large, zygomorphic, axillary, and are borne in terminal racemes, and have long tubular corollas, the posterior lobe of the corolla being somewhat dentate. The two-celled capsule, in common with most Scrophulariaceæ, contains a large number of very small seeds. The plants have chlorophyll, and are only semi-parasitic, being well supplied with foliage. Attachment to the roots of sorghum appears to be slight, and by means of small pad haustoria. While parasitism of sorghums has been proved, it is also suspected that maize is a host plant, while in one case

(*Continued on page 147*)

Linseed: A Useful Cash Crop

By R. S. BALL, *Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya.*

The crop will grow and yield satisfactorily under a wide range of conditions in the Colony, but its chief value lies in its use as an alternative cash crop to wheat at the higher altitudes of 8,000 feet and over, although it will also yield economic returns down to 6,000 feet. Further, linseed is also of value to the stock farmer who can grow a small acreage to provide a cheap protein-rich food for calf-rearing, and it is a much prized ingredient of concentrate mixtures for high-yielding cows. Linseed has been rather unpopular hitherto in this country for three reasons: firstly, the supposed exhaustive effect on the land; secondly, difficulties experienced in harvesting; and lastly, a lower financial return per acre than would be obtained from the cereal crops. With regard to the exhaustive effect on the land, this is undoubtedly a misconception which has arisen because linseed is not a weed-smothering crop, and therefore tends to leave the land rather foul after its removal; also because in many cases there are failures to obtain a good stand, and thus the soil is exposed to excessive erosion. Admittedly, financial returns per acre are on the average lower than those obtained from the wheat crop, but it is important to remember that linseed will rest the land from "Take-all" disease, which is likely to become increasingly serious in the high altitude wheat areas in the absence of a rotation of crops.

Varieties.—Where the crop is being grown for linseed it is very important to grow a variety which is suitable for oil crushing, and not a flax variety. For the former purpose, a large seed which will felt together to make a good cake when crushed, and which has a high oil content, is essential. The Department of Agriculture has tried a large number of varieties, the most outstanding of which are "Morocco", "Persian Gulf", and "La Plata". "Morocco" and "Persian Gulf" are good yielders, and are about thirty days quicker maturing than "La Plata". One other variety, "Redwing", is worthy of mention, for it is very quick maturing, its period of growth being only about 4½ months, as compared with 5½ to 6 months for the other varieties; but it suffers from the disadvantage that it is rather small seeded as compared with the others and has a slightly lower oil content, and hence is not so suitable for crushing.

Cultivation of the Crop.—It is essential that the crop should be grown on clean land, for, as previously mentioned, it does not form much bulk or close up between the rows, and has therefore little weed-smothering capacity. In order to ensure clean land therefore, the fields should be disked or cultivated after the previous crop, and ploughing delayed until a good germination of weeds has been obtained. Linseed, like wheat, likes a fairly stale furrow, and for this reason the land should not be cross-ploughed, but should be reduced to a sufficient degree of fineness with cultivators and harrows. If the soil is loose, it is desirable to employ a roller.

It is very necessary to obtain a good stand, otherwise the field will be exposed to the effects of erosion and a very poor yield will result. The seed rate for the large-seeded varieties such as "Morocco" and "Persian Gulf" should be 70 lb. per acre, and it is only in this manner that a good yield can be obtained. For the smaller-seeded varieties, however, 45 lb. per acre are sufficient.

Drilling is performed with the wheat drill, the distance between the rows being 6 to 8 inches, or that normally used for wheat. It is important that the seed should not be buried too deeply; incidentally, this appears to be another common reason for failure to obtain a good stand. If there is a danger that the drill may sow too deeply, it is best to drill with the coulters raised off the ground; in effect, broadcasting in lines. The seed should be covered by harrowing and, if necessary, cross-harrowing. Provided that the land was clean prior to sowing, the crop should come away without further treatment; but if there should be a heavy germination of weeds it is possible to clean the linseed by running a single chisel tine between each row.

Harvesting of the Crop.—Provided that a good stand has been obtained, it will be found that the crop will ripen fairly uniformly, but where the stand is patchy it is frequently observed that ripening is very uneven, which presents a difficult problem if it is desired to harvest with a combine. An unfortunate feature of the plant from the harvesting point of view is the extremely tough nature of the straw, which tends to bind round the working parts of the machine. For these reasons, it is often preferable to pull the crop by hand, and to allow it to stand in the field till thoroughly dry, when it may be carted in to be threshed, either with a stationary thresher or, if such is not available, with the combine worked in a stationary position. It will be found that linseed threshes very much more readily when the straw is thoroughly dry, which it becomes after standing in the field. In all cases the crop is more readily threshed with a drum of the high-speed beater type than with that of the peg type. It is essential to present a well dressed sample for sale; it can be dressed satisfactorily in the ordinary corn winnower, provided an inclined screen is fitted with a slightly smaller mesh than that normally used for wheat.

Yields.—Under favourable conditions the crop should yield heavily. Even at the rate of five bags per acre it should be profitable. At as low a price as Sh. 12 per bag a return of Sh. 60 per acre would then be obtained, a figure which should yield an adequate profit to the grower.

A Parasitic Weed of Sorghums

(*Continued from page 145*)

roots of a *Rhamphicarpa* plant were suspiciously closely intermixed with those of a plant of cowpea (*Vigna sinensis*).

The extent of the effect of *Rhamphicarpa* on the sorghum is difficult to gauge, as it tends to appear later than Striga, and when the sorghum is well established. There is no great restriction of growth in attacked plants, but it appears in great numbers at the time when seed is setting, and there is a tendency for grain to be light and heads poorly filled.

Control methods follow those for Striga. Early uprooting and burning before seeds are set lies within the power of the native. Trap crops might be possible, but the plant seems to have a very definite season for its appearance and flowering. Where energetic measures in uprooting it are carried out, very small stands are to be found.

The plant has been recently gazetted in Tanganyika Territory, under the Plant Pest and Disease Ordinance, as a noxious weed.

Virus Diseases of East African Plants: II—Leaf-curl Disease of Tobacco

By H. H. STOREY, *M.A., Ph.D., East African Agricultural Research Station, Amani.*

There is no cultivated plant known to be susceptible to a greater number of different viruses than tobacco. The majority of these viruses produce symptoms of mosaic or leaf-spotting of various kinds, or kill the plant outright; they form a complex group, difficult to differentiate from one another, and some of them only little studied. An important African virus disease of tobacco, however, known as leaf-curl, is readily distinguished from all others.

Leaf-curl appears to occur in Africa wherever tobacco is grown. In East Africa it is known to be prevalent in Uganda, Tanganyika and Zanzibar. In Nyasaland it has been known for many years as "cabbaging" or "Frenching" (Hornby, 1932), in South Africa as "crinkly-dwarf" (Moore, 1929), and in Southern Rhodesia as "Frenching" (Hopkins, 1932). Reports of what is almost certainly this disease have been made from the Belgian Congo (Mayné and Ghesquière, 1934), and West Africa (H. A. Dade, *in lit.*). Recent observations in South Africa (E. S. Moore, 1934) and Southern Rhodesia (Hopkins, 1932) show that losses from this disease tend to grow more severe; we have evidence that in Zanzibar it may destroy a whole crop. There can be little doubt that in many parts of East Africa leaf-curl is the most serious disease with which the tobacco-grower must contend.

The cause of leaf-curl disease remained obscure, or was incorrectly assigned, until, in 1931, work at Amani showed that it was due to a virus (Storey, 1931), and opened the way for rational measures of control. At about the same time, Thung (1932) studied in Java a disease, or group of diseases, known as "Kroepoek" or "Krulziekte", closely similar to leaf-curl in all characters, and possibly identical with the African disease.

THE SCIENTIFIC ASPECT.

(1) *The Effect of the Disease.*—The leaf-curl virus is somewhat exceptional in producing normally no chlorosis, either general or in a mosaic pattern. Its characteristic effect is to induce hyperplastic

FIG. 1.—Leaf-curl disease in Connecticut Havana variety, at flowering stage; diseased.

growth in the form of enations upon the lower surface of the leaves (Figs. 5 and 6). These enations are located along the smaller veins; in them chlorophyll is strongly developed giving them the same dark green colour as the upper surface of the leaf itself. Normally the enations amount to no more than a thickening of parts of the leaf-veins, irregularly distributed (Fig. 5), but at times they may grow out into frills, or cups of considerable size. Enations may occur also on the fruit-capsules.

The enations are usually accompanied by uneven growth of the main veins and leaf-lamina, so that the leaves are fantastically distorted, crinkled and twisted (Figs. 1, 3 and 4). The plant is generally stunted, and the growth of the flowering stems in particular is reduced (Figs. 1 and 3).

FIG. 2.—Leaf-curl disease in Connecticut Havana variety, at flowering stage; healthy plant for comparison.

The early symptoms of this disease often take the form of a clearing of the veins of a young leaf (a common preliminary symptom in many virus diseases). Usually this effect is transitory, but rarely the pale network, visible from the upper surface, may persist. In Java, Thung (1932) has attributed this effect to a virus distinct from that causing the enations, but work at Amani has failed to confirm the validity of any such separation locally.

In East Africa there is considerable variation in the severity of the symptoms of this disease. In its mildest form it may manifest itself only by slight thickening of parts of a few veins, without appreciable distortion of the leaf. These differences in manifestation are due in part to climatic differences, possibly also to soil differences (Hornby, 1932), and perhaps also to differences in the virulence of virus strains.

This disease is not to be confused with a hereditary abnormality known as "curly-leaf" in South Africa. Such abnormal plants are described (Moore, 1929) as bearing leaves of a very dark green colour, narrow and inrolled upwards. The veins are thickened on the under-surface, and the texture of the leaf is velvety. This abnormality has not been reported from East Africa.

(2) *Transmission of the Disease.*—The leaf-curl virus has not been transmitted by mechanical inoculation of the juice of diseased plants. It is readily transmitted through a graft. It is not carried in the seed of tobacco.

Natural transmission occurs through the agency of a White Fly (*Aleurodidæ*). The demonstration of the activity of this

vector at Amani (Storey, 1931) was followed by similar experimental proof in Southern Rhodesia (Hopkins, 1932), Nyasaland (C. W. Arnold, *in lit.*), and South Africa (A. P. D. McClean, *in lit.*). Previously, Ghesquière (*in lit.*) had reached the same conclusion in the Belgian Congo, but has not published his results. In Java, Thung (1932) also obtained transmission of Kroepoek with a White Fly, although there is some doubt whether the species there concerned is identical with that in Africa.

There are features in the transmission process by this vector that remain obscure. Transmission experiments have been successful only by the method of infesting tobacco seedlings with large numbers of adult White Fly taken from a diseased plant. Any attempt to confine the insects to particular areas of the leaves of the experimental plants resulted in failure.

No other insect vector is known. Trials have been carried out with certain other insects that occur on tobacco, but without success.

The Aleurodid is a species of *Bemisia*, close to or perhaps identical with the *B. gossypiperda* of Misra and Lamba. The life-history is that customary for this group; the eggs are laid on the leaf, the immature stages are sedentary and scale-like, while the adults are winged and alone able to move from plant to plant. In the Tanga District there is an annual rise and fall in the White Fly population. Infestation reaches a maximum in the hottest season and falls to a minimum about August.

(3) *The Range of Plant Species Affected.* — Enations, similar to those found in tobacco, have been reported also in cotton (in Nigeria and the Sudan), and in *Vernonia* spp. and *Sida* spp. in Tanganyika, Nyasaland and Southern Rhodesia. They are known also in a number of other plant species in Java (Thung, 1932, 1934), and India. A species of *Ageratum* is suspected of being a host of the virus in Rhodesia (Mossop, 1932). At Amani the virus was transmitted to tomato plants, which were stunted and curled, but failed to produce characteristic enations.

The leaf-curl disease of cotton has been fully studied by Kirkpatrick (1930-31) in the Sudan, and has been shown to be transmitted by a *Bemisia* sp., possibly identical with that on tobacco. The cotton disease is, however, unknown in East East Africa, and susceptible varieties of cotton grown at Amani remained healthy

FIG. 3.—Leaf-curl disease in Sterling variety.

when tobacco all contracted leaf-curl. We may conclude that in East Africa the disease is not intertransmissible between tobacco and cotton; although it is uncertain whether this is due to a difference in the viruses, to a difference in the insects, or to some other cause.

In one experiment at Amani leaf-curl was successfully transferred by White Flies from *Vernonia iodocalyx* O. Hoffm. to tobacco. Later experiments on the same lines failed. The reciprocal experiment—from tobacco to *Vernonia*—produced vein-clearing but not the full symptoms typical of the disease in *Vernonia* in the field. No experiments have been done in transmission between the other weed-plants mentioned and tobacco. The identity of the viruses causing leaf-curl in the range of weed-plants that show typical symptoms must for the present be regarded as doubtful.

FIG. 4.—Leaf-curl in young plant of Connecticut Havana variety. Experimental plant infected by White Fly.

THE PRACTICAL ASPECT.

(1) *Recognition of the Disease.*—It cannot be too strongly emphasized that, in spite of the name by which it is known, leaf-curl disease cannot be certainly diagnosed by the curling and distortion of the leaves. The character that distinguishes this disease from all other causes of leaf-curling is the presence of the outgrowths from the veins on the lower surface of the leaf. The leaf of a suspected plant should be held up to the light; if the smaller veins show up a decidedly darker green than the lamina, the diagnosis is certain (Fig. 5); if the veins are markedly thickened (Fig. 6), or there are cup-like outgrowths, the matter is easy, but these growths are not always present. Sometimes the darkening of the veins is so slight as to leave the diagnosis in doubt, even to a person well acquainted with the disease. In such instances, however, the examination of neighbouring plants will generally reveal some that have the thickening well developed.

Nevertheless, once the disease has become familiar, it can usually be recognized by the special character of the leaf distortion (*see* Figs. 1 and 3). In particular, the tendency for the leaves to bend down and so to enfold the stem (Fig. 3) is characteristic. Again, however, the observer should be warned that some tobacco varieties have a natural tendency to a somewhat similar curling of their leaves even though healthy; confirmation of the diagnosis of leaf-curl disease should always be sought in the thickening of the veins.

(2) *Control of the Disease.*—Since the leaf-curl virus cannot be transmitted by mechanical inoculation, the tobacco-grower need take no precautions to avoid its spread from plant to plant by his workmen. If mosaic disease be present there is great danger that labourers, in

the course of priming and topping, will carry it to every plant in the field. With leaf-curl no such danger exists.

Spread of leaf-curl is dependent on the insect-vector. If we break the cycle, plant-insect-plant, we can control the disease. The virus is not carried by the seed of tobacco; if throughout their growth the plants can be protected from infestation by White Flies *carrying the virus*, they will remain healthy.

How may this be done? We may dismiss any idea of direct control of the insects, by spraying or similar means. We may, however, under some circumstances, take advantage of the natural control of the insect that operates seasonally. In Amani a healthy crop of tobacco has always been grown successfully in the winter months. While the explanation of this is not certain, I suspect it is due to the almost complete disappearance of White Flies during that season. Generally, however, the growing season in any district is decided by other factors, and a change is impossible.

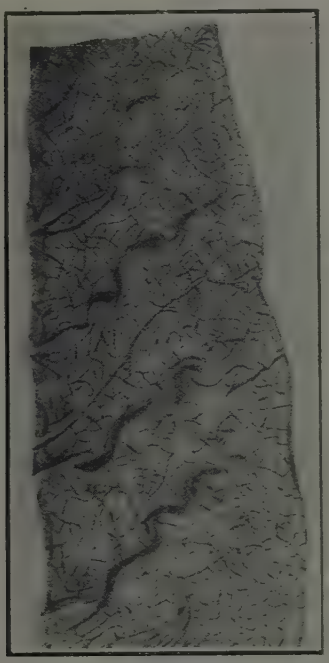

FIG. 5.—The characteristic symptoms of leaf-curl disease. Portion of leaf viewed from below by transmitted light. Note the thickening and darkening of the smaller veins.

White Flies that are not carrying the leaf-curl virus are, from our present point of view, harmless to the crop. If then we can ensure that none pick up the virus, we can regard their presence with equanimity. Undoubtedly the most important source of virus is diseased tobacco plants. For this reason great stress is laid, in Rhodesia (Storey, 1932; Hopkins, 1932) and elsewhere in the south, upon the thorough cleaning of the tobacco land after the crop is reaped. Tobacco roots left in the ground ratoon freely; many contract leaf-curl; they then act as a fruitful breeding-ground for the production of a crop of infective White Flies (Mossop, 1932). It is of the utmost importance that every ratooning tobacco stump be removed well ahead of the planting of a new crop. The longer the fallow period, during which no tobacco is growing, the better.

Even though this precaution be taken, there remains a risk that the virus may be carried over to tobacco from weed-hosts. It is impossible to assess the extent of this risk in the absence of fuller experimental evidence upon the transmission of the virus from weed-hosts to tobacco. In Java it has been shown (Thung. 1934) that the virus from certain weeds may pass to tobacco. and a benefit has been noted from the selective weeding of a zone 50 metres wide around tobacco fields. It is possible that similar action, directed particularly to the removal of *Vernonia* spp. and *Sida* spp..

might be effective in East Africa. In particular, care should be taken to isolate seed-beds; the clearing of a zone around them, free from all vegetation, is practicable and likely to reduce the incidence of the disease at a stage in the plants' growth when its effect is most serious.

There remains one method of control that, if it were possible, would provide a most advantageous solution to the problems: that is the use of immune varieties of tobacco. An attempt has been made at Amani to breed such immune varieties; sixteen imported standard varieties were grown through several seasons with selection of the seed from plants that survived infection. In the end all the selected lines succumbed to the disease. Attempts to obtain immunity by crossing with other species of *Nicotiana* also failed. There seems to be little prospect that control along these lines can be attained.

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FIG. 6.—An enlarged view of the enations on the lower surface of the leaf of diseased tobacco.

A Simple System of Farm Accounts and Records*

By V. LIVERSAGE, *B.Sc., M.S., N.D.A., Agricultural Economist, Kenya Colony.*

The commercial basis of modern farming renders some sort of book-keeping almost indispensable. A large proportion of farmers, however, have no knowledge of the principles of double-entry and no need for the elaborate methods employed in other industries.

The progressive farmer needs information relating to the practical side of his operations in addition to that which is recorded under the ordinary accounting systems.

The object of this bulletin is to set out in as simple a form as possible a system whereby the farmer may combine the orderly arrangement of data concerning his financial transactions with such additional records as will prove of assistance to him in the economical management of his farm and in the building up of a system of farming which is designed to make the best use of the economic circumstances existing. It should not be thought that the faithful recording of every item in the following pages will necessarily be productive of increased financial success in farming; the records themselves are only a means to an end. If the matter is allowed to rest after the accounts have been balanced and the records totalled, the work will have been in a large measure wasted. The purpose of the accounts and records is to provide a groundwork of actual fact as a basis for intelligent study.

* This was published as Kenya Department of Agriculture Bulletin No. 1 of 1934. It is now out of print. As several requests have been received for copies since supplies were exhausted, and since the matter may be of interest in other territories, it has been decided to republish the article in this Journal.

ACCOUNTS.

These consist of three main portions:

A statement of the position at the beginning of the year (or other period chosen as the accounting period).

A record of transactions made during the year.

A statement of the position at the end of the year.

Date of Opening and Closing the Books.—There is no particular reason for adhering to the calendar year as the accounting period. From the farming point of view it is best to choose a period which as far as possible coincides with the crop year. The closing date should be one at which the season's produce has been sold and the money received, and at the same time the minimum of expenditure has been incurred towards the operations of the following season. Stocks on hand or in transit will then be at the lowest point and a minimum of estimation of values will be necessary. At the same time it is advisable that the accounts should be easily checked against the bank pass-book, and from this point of view it is well to choose a date coinciding with the balancing of accounts by the bank.

Opening Statement.—This consists of a valuation of land, live and dead stock, and growing crops, with a statement of debts outstanding and of the amount of cash on hand. The closing valuation of one year is of course the opening valuation of the following year. The items to be included may be classified and the opening statement drawn up as follows:

SUMMARY OF VALUATION

As at (*date*).....

	Sh.	cts.	Sh.	cts.
ASSETS—				
Land				
Plantations				
Permanent Improvements				
Live stock				
Produce and consumable stores on hand				
Buildings, etc.				
Implements, machinery and plant				
Cash in hand				
Cash at Bank				
Accounts receivable ..				
Other assets				
Total Assets ..				
LIABILITIES—				
Loans payable				
Accounts payable ..				
Total Liabilities				
NET CAPITAL .. .. (Total assets *minus* total liabilities)				

It will be convenient to exclude as far as possible items not directly connected with the farm business. This account book is designed for farm and not for personal use.

Record of Transactions.—The simplest way of dealing with the financial transactions is to draw up a cash record and leave credit transactions until payment is actually made, noting the transaction meanwhile in the diary.

A convenient method is to classify items at once on a prearranged plan and to enter them in appropriate columns on pages ruled for the purpose. The pages may be ruled as illustrated below, utilizing the long way of the paper in order to allow room for a sufficient number of columns.

Each transaction is entered twice, once in the totals column at the right and once in one of the columns under "Classification of Expenditure". A classification of

EXPENDITURE

Date	Particulars	Classification of Expenditure					Total
		S. C.	S. C.	S. C.	S. C.	S. C.	S. C.
	Brought forward (*Items*) ..						
	TOTAL .. (*cd. fwd.*)						

expenditure must be drawn up at the beginning of the year and adhered to throughout. The farmer can follow his own devices as to the classification to be adopted. A fairly simple one might be as follows: —

Capital Expenditure.
Purchase of Horses.
" Cattle.
" Sheep.
" Pigs.
" Poultry.
Fertilizers.
Feeding Stuffs.
Native Wages.
Rations for Labourers.
Repairs.
Petrol, Kerosene and Oil.
Veterinary.
Transport.
Interest (actually paid) and Bank Charges.
Miscellaneous.

These are intended merely as a guide, and the farmer should devise a classification which best suits his own purposes. The columns should be totalled at the end of each month, and the addition should be checked by making sure that the sum of the totals of the classification columns is equal to the total of the "Total" column on the right-hand side of the page.

The receipts may be treated in the same way. In addition to the cash receipts, however, entries should be made

for the value of farm produce consumed in the household. The value of the produce so consumed really represents drawings by the farmer from the business, and is part of the profit earned. Produce consumed by employees, on the other hand, is equivalent to wages paid; its value should be entered in the first place so as to show the total production of the farm, and subsequently entered on the cost side of the Profit and Loss Account (q.v.). The receipts pages may be ruled as follows:—

RECEIPTS

Date	Particulars	Classification of Receipts					Total
		S. C.	S. C.	S. C.	S. C.	S. C.	S. C.
	Brought forward						
	(*Items*)						
	TOTAL .. (*cd. fwd.*)						

VALUE OF FARM PRODUCE CONSUMED IN HOUSEHOLD

Kind of Produce						Total
	S. C.	S. C.	S. C.	S. C.	S. C	S. C.
Brought forward						
Consumed during month ..						
TOTAL .. (*cd. fwd.*)						

A good plan is to keep a page (or more, if necessary) for the expenditure and one for the receipts of each month, using the left-hand page for expenditure and the right-hand page for receipts and produce consumed in the household, and to total the columns at the end of each month, keeping a running total until the end of the accounting period.

Closing the Accounts at the End of the Year.—When the monthly records are all complete, the next step is to make a short summary of the year's operations. For this purpose it is usual to draw up a Trading and Profit and Loss Account. The following items will be required:—

(*a*) A valuation drawn up at the end of the accounting period, in the same way as at the beginning. This will in due course form the opening valuation for the succeeding year.

(*b*) The totals of the various columns of expenditure and receipts, and of the value of produce consumed by the household.

(*c*) A computation of the amount which should be allowed for depreciation.

With regard to (*c*) a schedule of depreciating assets should be drawn up which will serve both for the computation of depreciation allowance, and also for the valuation of depreciating assets. Depreciating assets will include buildings, implements, machinery, etc. The method of valuation and computation of depreciation allowance is shown in the following specimen ruling:—

Date.....

Item	Original Cost	Year Purchased	Estimated Life	Amount written off Annually	Present Value

In regard to items which are not ordinarily intended for sale, the financial result should not be confused by changes in the rates of valuation. Such changes introduce elements of "paper profits" or

losses which have no relation to actual fact. Land should be carried forward at its purchase price each year and improvements entered separately. It is preferable to maintain a uniform value per head of breeding stock not intended for sale. Valuations of goods intended for sale should be kept on the conservative side, or a fictitious loss may result in the following year in the event of final receipts not coming up to expectation.

The items necessary for the construction of a final summary of the year's results are now ready. The summary will consist of two parts: —

(*a*) A trading and profit and loss account, dealing with the results of the year's operations; and

(*b*) A balance-sheet, setting out the position of the business at the end of the year. This is drawn up in the same way as the opening valuation dealt with on a former page.

Trading and Profit and Loss Account. —This may be drawn up as shown below, expenses being entered on the left-hand side and receipts on the right.

The item "Value of board and allowances to employees" on the left-hand side is to set off against the value of farm produce consumed in the household any portion which is really consumed by employees. This is not, of course, a portion of the owner's drawings but is an item in the cost of production.

Production Records.

These should not be neglected, as the information often proves as valuable to the intelligent farmer or manager as the financial accounts. The record pages should be so designed as to facilitate the entering up direct of the various items. It is cumbersome and inefficient to keep such records in pocket-books or on loose sheets of paper. A convenient method is to rule pages in the manner illustrated

	Sh. cts.		Sh. cts.
Net Capital at beginning of year		Net Capital at end of year	
Expenditure :		*Receipts :*	
(*e.g.*)		(*e.g.*)	
Purchase of Live Stock		Sales of Live Stock	
Purchase of Implements, etc.		Sale of Live Stock Produce	
Purchase of Fertilizers		Sale of Maize	
Salaries		Sale of Coffee, etc.	
Wages and Allowances		Value of Farm Produce consumed in household	
Repairs			
Transport			
Kerosene, oil, etc.			
Interest (actually paid)			
Sundries			
Value of Board and allowances to employees (not elsewhere entered)			
Balance (Operating Profit) *carried down*		Balance (Operating Loss) *carried down*	
TOTAL		TOTAL	
Balance brought down		Balance brought down	
Interest (unpaid) on capital			
Salaries (unpaid)			
Balance (Net Profit)		*Balance* (Net Loss)	
TOTAL		TOTAL	

below, headings being inserted to suit the system of farming followed. In the case of a dairy farm, something on the following lines might be convenient: —

LIVE STOCK PRODUCE RECORD

Month.....

Date	Amounts obtained					Amounts despatched			
	Milk Produced	Whole milk fed to calves	Cream Separated	Wool clipped	Eggs	Milk	Butterfat	Wool	Eggs
	Gal. or lb	Gal.	Gal.	lb.	Dz.	Gal.	lb.	lb.	Dz.
1 2 (etc.)									
TOTAL for month *Bt. fwd.*									
TOTAL to date ..									

For a crop farm the headings might be thus: —

CROP PRODUCE RECORD

Month.....

Date	Amounts picked, threshed, etc.						Amounts despatched	
	Coffee		Maize	Wheat	Beans	Potatoes	Coffee	Maize
	By ticket labour	By cent pickers						
	Debbies		Bags	Bags	Bags	Bags	Cwt.	Bags
1 2 (etc.)								
Total for month *Bt. fwd.*								
Total to date ..								

On a stock farm, a monthly live stock record should be kept on the following lines: —

LIVE STOCK RECORD

Month.....

	No. on farm at beginning of month	No. purchased during the month	No. transferred in during the month	Births	Deaths	No. transferred out during the month	No. sold or slaughtered during the month	No. on farm at end of month
Horses ..								
Cattle: Working Oxen .. Stock Bulls Cows in milk .. Cows dry (etc.)								
Total Cattle.. (etc.)								

The columns headed "Transferred in during the month" and "Transferred out during the month" are used when animals are transferred from one class to another. For instance, when a dairy heifer calves down and takes her place in the milking herd, the transfer is recorded as a "transfer out" of the dairy heifer class and a "transfer in" to the cows in milk class. Similarly when cows are transferred from the milking herd to the dry herd, and vice versa.

If the records are complete the total of the four left-hand columns will equal the total of the four right-hand columns with each kind of animal. For example, taking the figures for "total cattle", the followings sums should give the same result: —

Number on farm at beginning of month	
Number purchased during month ..	
Number transferred in during month..	
Births	
TOTAL ..	

Number on farm at end of month ..	
Number sold or slaughtered during month	
Number transferred out during month	
Deaths	
TOTAL ..	

At the end of the year it will be of advantage to summarize the monthly live stock records so as to determine the average number of stock on the farm during the year. The method is as follows:—

	January beginning	Jan. end	February	March	April	May	June	July	August	September	October	November	December	Total	Average (Total ÷ 13)
Horses ..															
Cattle: Working Oxen ..															
Stock Bulls															
Cows in Milk ..															
Cows, dry (etc.)															

The resulting averages will serve for the calculation of average stocking per acre, average milk yield per cow in milk, and per cow in the herd, average proportion of dry cows in the herd, etc.

Monthly Labour Record.—Many farmers find it advantageous to analyse their expenditure on labour for different tasks. The usefulness of such an analysis depends upon the system of farming pursued. In coffee-growing and similar types of farming it is of considerable importance to have information as to the labour cost of various operations. On dairy farms the matter is less important, not only because labour cost does not bulk so large in the annual profit and loss account, but also because the division of labour is less clear cut. Milkers may be employed during part of the day on crop production. The proportion of their wages attributable to milking and to crop production is a moot point and is without much practical significance. Nevertheless, many dairy farmers will often find it useful to have a record of the time spent in various portions of the farm work.

The particular captions used in the analysis of labour will depend upon the kind of farm and the ideas of the farmer or manager. The following headings are suggested for various types of farms; they are intended merely as a guide, and should be modified, reduced or amplified as desired:—

Coffee Estate.

Development—
- Clearing and Planting.
- Maintenance of Young Trees.
- Other Capital Works.

Maintenance—
- Cultivation and Weeding.
- Pruning.
- Manuring.
- Pest Control.
- Picking and Factory Work.
- Transport.
- Repairs.
- Estate and General.
- Private.

Dairy Farm.

- Capital Works.
- Milkers.
- Dairy.
- Herders.
- Sheep.
- Pigs.
- Transport.
- Lucerne.
- Silage.
- Estate and General.
- Private.

Maize Farm.

Capital Works.

Maize—
- Cultivating and Planting.
- Intercultivation.
- Harvesting.
- Shelling, Bagging and Transport.

Other Crops—
- (As required).

The ruling of the labour page might be as follows:—

LABOUR RECORD

Month.....

Date	Labourers employed					Cash Wages paid	Analysis of Labour: Number employed on						
	Men	Women	Children	Casual	Total	Sh: cts.							
1													
2													
(etc.)													
Total for month *Bt. fwd.*													
Total to date													

The cash allocation may be calculated monthly or on the total at the end of the year. The latter method is much more economical of time and trouble.

A strictly accurate allocation of labour costs would necessitate recording the rate of pay of each worker employed on each task. It is doubtful if there is any need to undertake the large amount of clerical work involved in this method. The work can be very much shortened and reasonable accuracy achieved by using the following method:—

(i) Find the total of labour-days employed during the year.

(ii) Find the total cash wages paid and add to this the amount spent on rations and other allowances.

(iii) Total the analysis of labour columns and see that the grand total agrees with the total labour-days under (i).

(iv) Estimate approximately the comparative rates paid on the different tasks shown in the analysis columns.

(v) Multiply the totals of the analysis columns by the wage-ratios decided upon as in (iv).

(vi) Add up the resulting figures and divide the total into the total labour cost on the farm. This gives a correction constant for the figures obtained as in (v).

(vii) Multiply the results of (v) by the constant obtained as in (vi). The result is an allocation of labour costs which should agree with the total actually spent on labour and which should be sufficiently accurate for practical purposes.

Where there are marked differences between the rates of wages paid for different tasks it will be possible to estimate them sufficiently accurately for the above purpose. It is not the actual rate of wages paid for different tasks, but the ratio between them which is the real basis of the calculation in (v). Where differences are merely accidental they are unimportant from a farm management point of view.

The method may be illustrated by the following example, from a coffee estate (1930-31):—

(i) Total Labour days 38,182
(ii) Cash Wages .. Sh. 21,382
Rations and allowances 6,993

Total .. Sh. 28,375

	Cultivation and Weeding	Pest Control	Manuring	Pruning	Picking and Factory	Development	Other
(iii)	10,819	237	578	5,479	13,016	351	7,702
(iv)	15/-	20/-	17/-	25/-	25/-	17/-	17/-
ratio	1	1.3	1.1	1.7	1.7	1.1	1.1
(v)	10,819	308	636	9,314	22,127	386	8,472
Total of (v)	= 52,062						
(vi)	Sh.28,375 ÷ 52,062 = Sh.0.545						
(vii)	5,896	168	347	5,076	12,059	210	4,617
Total of (vii)	= Sh. 28,373						

The discrepancy between the resulting total and the actual total in (ii) is due to the division in (vi) being carried to an

insufficient number of places. The difference is only Sh. 2, and this can be adjusted roughly over the different columns.

The foregoing methods of analysis may also be used, if desired, for ox labour and tractor work. The principle is the same but the actual details may be suitably modified.

Monthly Diary.—Space should be provided each month under a heading "Diary", and should be used for notes with regard to the weather, the progress of work, condition of crops, diseases and pests and methods of treatment used, and, in fact, any matter which might be useful later on for reference purposes.

It should also be used for making notes of any credit transactions which are entered into, pending the appearance of the entries in the cash record. Such entries will be used for reference purposes in case of doubts arising later, and will also assist in the compilation of the inventory at the end of the year.

Land Utilization.—Finally, a record of the areas of crops grown and harvested, and of utilization of the land during the year might be drawn up along the following lines: —

	Long Rains	Short Rains	Total area	Total Production	Production per acre
	acres	acres	acres		
Coffee (1–3 years) ..					cwts.
Coffee (3–6 years) ..					
Coffee over 6 years					bags
Maize for grain ..					bags
Wheat for grain .. (etc.)					bags
Fallow					
Pasture					
Waste					
Total area					
Less area cropped twice					
Area of farm ..					

The entry "area cropped twice" is included since land is sometimes cropped twice during the year, and if both crops are entered the resulting total area will be greater than the actual area of the farm.

Conclusion.—It is not suggested that farmers should keep all the records detailed in the foregoing. The individual may make his own choice as to which he desires to keep. With several of the records, as of the columns shown, any particular farmer may not be concerned. The individual may desire to modify the form of some of the records shown and may be able to improve upon them for his own purposes. The aim of the writer will have been achieved if the specimens presented assist farmers in drawing up a form suitable for themselves and if they at the same time draw attention to the valuable information which faithfully kept records can be made to provide.

If entries are made in a systematic manner every evening the work involved will appear negligible. If, however, they are deferred for even a short time, the effort of recalling facts will make the work so burdensome that it will be likely soon to be abandoned in disgust.

Coffee Fermentation*

By T. L. McCLELLAND, *M.C., Plant Inspector, Kenya.*

The subject of fermentation of coffee is occupying much of our time and thoughts at the present moment, as one invariably hears the statement that it is quality we want, and this is bound up chiefly in preparation. Although fermentation is a general practice in this country it is still in its infancy as far as its effect on quality of coffee is concerned. I say this unreservedly, as even to-day many workers on the subject throughout the coffee-growing world are still not convinced that fermentation is necessary to quality.

The question now arises: What is quality? Is it appearance, including colour and size, or is it some inherent quality in the bean over which we have no control at the moment, or a combination of these factors with the inherent quality given the name of acidity? Good cultural practices, given normal climatic conditions, will undoubtedly, as in most horticultural work, improve the size of the bean, but what is responsible for colour and acidity? These are the factors which one imagines can be produced by fermentation and the subsequent methods of drying and curing. The experiments recently conducted give no definite proof that this is so, and one is led to believe that coffee may be ruined during the preparation, but the particular characteristics of the bean which constitute quality may be maintained, but not improved to any extent, by preparation. It might be of interest to read you an extract from a letter received by Mr. Trench, Senior Coffee Officer, from a very successful coffee planter in Guatemala.

He states that in his opinion the chief factors to produce quality are as follows:

"(*a*) Altitude.
(*b*) Properly cultivated trees, preferably not over 20-25 years old at higher altitudes and 15-20 years old at the lower altitudes.
(*c*) In Central America, suitable shade is essential.
(*d*) Loose top soil, with abundance of humus, and a heavier subsoil.
(*e*) Annual rainfall around 100 inches, properly distributed, although a coffee tree will flourish with much more or much less than this amount.
(*f*) Coffee fully ripe when picked.
(*g*) Plenty of sun."

These remarks are in order of importance, and it is noticeable that factory preparation is not included as a factor in the production of quality. He, however, makes the following observations in regard to preparation:—

"Coffee pulped as soon as possible after picking, always on the same day. Abundant clean water supply. Scrupulous care in fermenting and washing, making as many separations as possible in the wet process. Uniform drying, sun or mechanical. When dry, coffee should be left in parchment in piles in dry store for some weeks, to even up. Careful hulling, blowing, and hand-picking. In a normal year, if the above suggestions are carefully adhered to, hand-picking should not be necessary, except possibly in thirds and fourths. Elimination of defective beans is always better in the wet process than in the dry.

"The term quality is made in a broad sense, relating to make of bean, colour and liquor, and I do not think that quality can be improved in the process of preparation. It can only be maintained or damaged. I cannot see that fermentation alters the liquoring qualities. These are produced primarily by climate, soil, and altitude."

* A paper read at the Coffee Planters' Days, Nairobi, July, 1935.

There are many home truths in these remarks, and although they coincide with the ideas taught in the past in Kenya, they still might be more profitably studied. Certainly they cannot be ignored, coming from a planter with many years' experience and a reputation for first-grade coffee.

Assuming therefore for the present that quality can only be maintained and not improved in preparation, the question arises as to the best means of ensuring this.

The series of experiments conducted at the Scott Laboratories, the results of which will be discussed by Dr. Case this morning, may, I hope, throw a preliminary light on the matter.

These experiments are a continuation of those initiated and conducted by Mr. Trench, Senior Coffee Officer, during the 1932-33 season, and which unfortunately had to be abandoned the following season owing to the severe drought prevailing. It gave us much pleasure that Dr. Case, Bio-chemist, Coffee Board, wholeheartedly co-operated in the experiments.

The grateful thanks of the officers engaged in the work are due to those firms in Nairobi and London who liquored and reported on the various samples, and some idea of the work entailed will be realized when I state that some 400 samples were prepared. It is also noteworthy to mention here that Nairobi firms did all the tests gratuitously.

While in no way wishing to disparage the valuable assistance given by the firms, it must be noted that the differences of opinion shown by individual liquorers in many cases has made it extremely difficult to arrive at any satisfactory conclusion on the particular treatment. This is really to be expected, as the liquoring of coffee is largely a matter of personal taste, and cannot by any means be regarded as an exact science. This view has also been expressed by one of the leading coffee merchants in London.

The general methods of experimentation, in order to eliminate as many external factors as possible, were as follows, unless otherwise stated in any specific experiment: —

Only ripe cherry was used.

By diverting the flow of coffee every five minutes into each tank, the tanks were completed within a very short time of each other. Fermentation thus commenced at approximately the same time in each individual experiment.

The tanks and machinery were thoroughly cleaned before the commencement of each experiment.

On the completion of pulping the "lights" were floated off so as to eliminate uneven fermentation; this included the removal of Antestia-damaged beans.

An analysis of the water in which pulping and fermentation took place was made by Mr. Beckley, Senior Agricultural Chemist, and Dr. Case. Both agreed that no detrimental effects would ensue in either fermentation or liquor from the use of this water.

The fermenting coffee was stirred, to ensure complete and even fermentation.

All trays of washed coffee of the same experiment were filled as evenly as possible, and only Grade A used.

The coffee in the trays was turned regularly during the drying process.

All samples were hulled in a Gordon "Africa" huller, which was thoroughly cleaned out after each sample had passed through.

Hulled samples were hand-picked and packed in cellophane bags for distribution to the various liquorers.

Unless otherwise stated, all fermentations were carried out under cover; that is, the tanks were situated inside the factory building.

The only experiments which I will deal with personally this morning are an antithesis to the subject of fermentation. These are experiments which did not come under the scope of Dr. Case's work, and include:—

Coffee from a shaded plantation *versus* coffee from an unshaded plantation.

Coffee from multiple stem young suckers *versus* old verticals *versus* single stem.

Drying and curing experiments.

Taking the first mentioned, shaded *versus* unshaded, the following results were obtained:—

Shaded coffee ... 20½ points.
Unshaded coffee ... 14½ points.

The liquorer reported that, whilst both samples were lacking in acidity, the appearance both in the raw and the roast of the "shaded" coffee was infinitely better than the "unshaded".

The second experiment, coffee from suckers *versus* old verticals *versus* single stem, gave an equivalent number of points in each case. I may add here that the old verticals had been properly handled, and were not in the condition which one sees so often on multiple stem plantations. In order to give you a picture of this, I would describe these trees as follows: A matted growth of secondaries from the base to the terminal of the primaries which may be laden with crop. From observations made when these conditions occur the coffee from such heads invariably looks much smaller than that produced on properly treated stems.

Drying and Curing Experiments.—The object of this experiment was to determine if any improvement could be gained in the appearance and liquor of coffee by various methods of drying and curing.

The following were the methods employed in the drying experiment:—

Entire sun drying.

Entire shade drying.

Sun drying to the commencement of the black stage, and then completing in the shade.

Shade drying to the black stage, and then completing in the sun.

Nairobi liquorers state that the liquor of the various samples is identical, and extremely little difference was found in appearance.

London, on the other hand, definitely place entire sun dried first, and shade and completed in the sun last, with slight variations in the other experiments.

No results of any appreciable value were found from the various methods of curing, but this experiment is being repeated this season.

I would like to add here that in all the experiments conducted the coffee had suffered severely from drought, and was not up to the standard in size or appearance, irrespective of the effect of the various treatments, and there is the possibility of such treatments having a more pronounced effect on a first-grade article.

I cannot finish these few remarks without acknowledging the very helpful suggestions and advice of Mr. Deutschmann and Mr. Bargeman, who paid many visits to the Laboratory during the experiments—the early hours of the morning very often finding them still at work with us.

The Climate and Weather of East Africa—II

By W. A. GRINSTED, *Acting Director, B.E.A. Meteorological Service.*

In the first article of this series, published in July, the general circulation of the atmosphere as affecting the tropical belt was described. Before proceeding to show how this general system is modified by the large land mass, and how the day-to-day variations of the system affect the weather of East Africa, a brief description of the general climatic conditions of the area will be given.

The East African territories may be divided broadly into five climatic zones, in each of which a certain general type of climate is experienced. These zones may be called "coastal", "lake", "inland plateau", "highland" and "northern frontier". A general description of these zonal types will be given, followed by a more detailed examination.

By the "coastal" zone is meant the belt of low-lying country extending inland from the coast, averaging from 50 to 100 miles wide, together with the outlying islands of Zanzibar, Pemba and Mafia.

The chief features of the climate of this zone are fairly high temperature with small range both during the day and year, constantly high humidity and maximum rainfall about April and May.

The "lake" zone includes the regions round the great lakes. The zone of influence of Lake Victoria extends up to one hundred miles from its shores, but the exact extent of the "lake" areas depends on the size and shape of the lake considered. The "lake" type of climate is very similar to the "coastal" type. The main difference is a somewhat lower temperature, due to the altitude. This is most noticeable in the case of Lake Victoria, which is 3,700 feet above sea level. In these areas the same small range of temperature and humidity is encountered as at the coast, but there is a difference in the incidence of rainfall.

The "inland plateau" includes the greater part of Tanganyika, and extends from the Zambesi up to the Kenya border, at an average height of about 4,000 feet above sea level. Its characteristic climate includes a large diurnal range of temperature and humidity, a wet season from December to April, with a tendency for a secondary minimum in January, and a definite dry season from June to September.

The most pronounced "highland" areas are the Kenya Highlands, the Usambara Highlands, and the Iringa Highlands, the latter extending down to the Livingstone Mountains. The highlands areas generally lie at an elevation of between 5,000 and 8,000 feet, but with mountains in the north rising well above these heights. Conditions over the highlands tend to be cloudy, and the mean diurnal range of temperature is fairly small. This mean range, however, results rather from a combination of various weather types and both warm days and cold nights may be experienced. Rainfall is very variable, and the incidence of rainfall during the year depends rather on the area considered.

Considering first the Kenya Highlands, there are two periods of maximum rainfall, when the sun is overhead and convection is strongest. When the sun is to the north the country is influenced by the trade winds from the south, which, although they may not cause much rain, do cause dull, cloudy and rather cold conditions. When the sun is to the south, air is drawn in from the

north, and this air having been well dried by passing over the land gives us clear sunny weather. In the more elevated sections of the highlands cloudier and moister conditions are met with, together with lower temperatures.

The Usambara Highlands have the same climate characteristics. The period between the two rainfall maxima is shorter, and after the sun has moved north there is a greater precipitation from the south-easterly trade wind.

The Iringa Highlands, being further south, have no definite break in the rainy season, and have a dry season while the sun is north. Also, being further inland, they are not affected by the trade current. In the south, in the Rungwe District, they come under the influence of Lake Nyasa, and some extremely heavy falls are registered. Tukuyu usually records at least 100 inches per annum, and no time can be counted on to be dry. The maximum is, of course, during the "rainy" season of December to April.

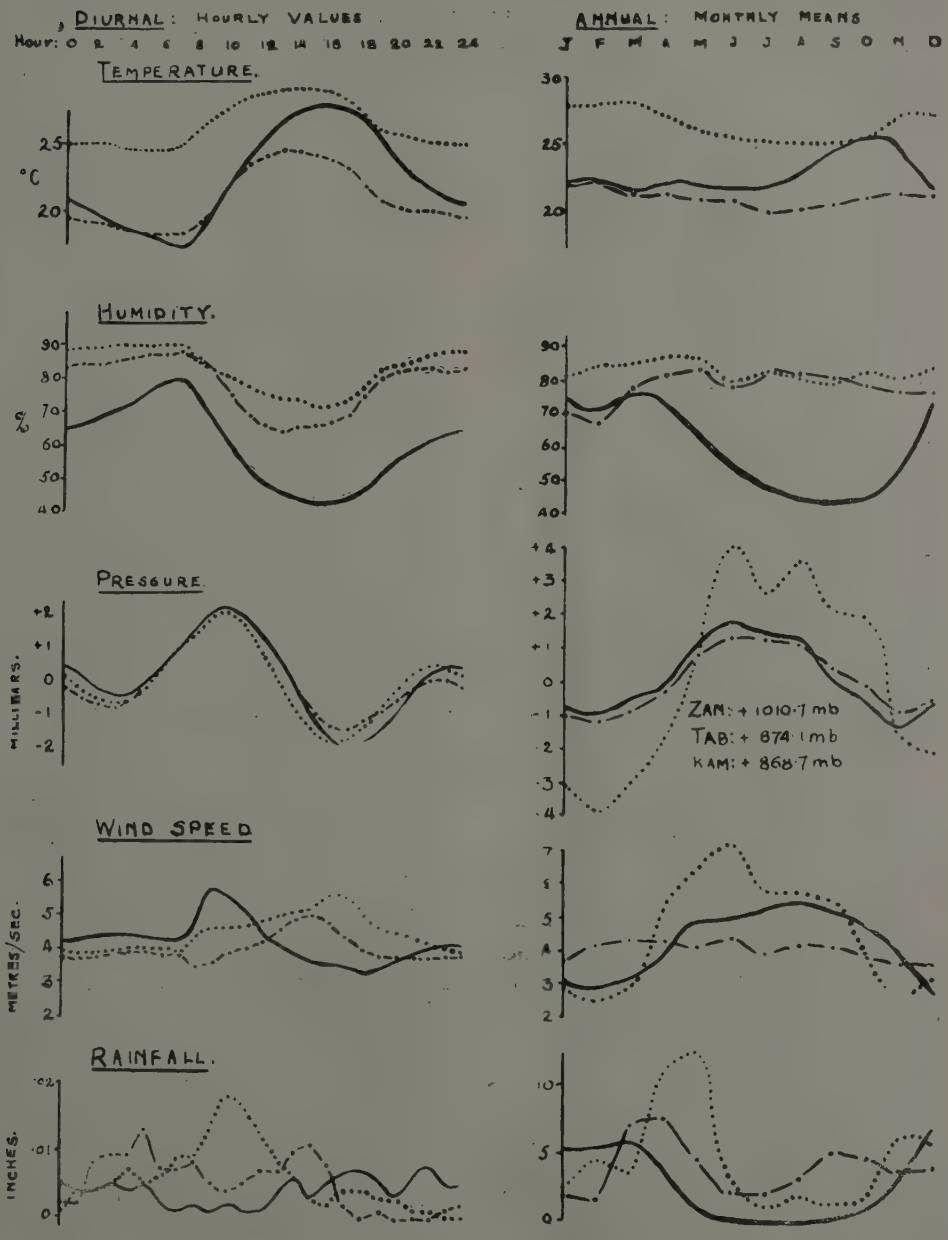
The climate of the Northern Frontier Province approximates to that of a desert over a great part of its area. There is no large mass of water for the promotion of convection showers, and the air is very largely desiccated before it gets there. Where there is rising ground, however, rain or mist results, and at Marsabit, which is at a height of 4,600 feet, mists are common from 3 p.m. to 10 a.m. In the low lying parts the temperature is high and rain rarely falls.

In order to illustrate the conditions more clearly and to facilitate explanations, the accompanying diagram shows the diurnal and annual variations of temperature, humidity, pressure, wind speed and rainfall for Zanzibar, Kampala and Tabora. The curves have been drawn from the means of hourly values obtained from the autographic records. In the case of Kampala and Tabora the means are for the period 1931-1934, but for Zanzibar only the hourly values for 1931 were available.

The general features outlined above may now be examined in more detail. Zanzibar is taken as having a typical "coastal" climate, Kampala a "lake" climate, and Tabora the "inland plateau" conditions.

The average temperature at Zanzibar for the year is seen to be 26.4° C. (79.5° F.); at Kampala the figures are 20.9° C. (69.6° F.), and at Tabora 22.6° C. (72.7° F.). As the normal lapse rate of temperature is approximately 3° F. per 1,000 feet, it will be seen that Kampala is cooler than the coast solely because of its altitude, and that Tabora is comparatively warm. An examination of the annual curves shows that the relatively high temperature at Tabora is due to the heat of September to November, i.e. when the sun is overhead and before the rains start. The ground gets heated up over a very large area, and there are no water masses near with the superimposed cool air to lower the temperature.

Looking at the diurnal variation, Zanzibar and Kampala have ranges of 4½° C. (8° F.) and 6° C. (11° F.) respectively, while Tabora has a mean diurnal range of 11° C. (20° F.). The reason for this disparity lies in the fact that on the coast and over the lake there is an abundant supply of water which may be converted into vapour. Part of the heat is expended on vaporizing a certain quantity of vapour, while in turn this water vapour is itself very opaque to long wave radiation and acts as a screen, both to incoming radiation during the day and outgoing radiation at night. In addition, the water is less easily heated than the land owing to its greater specific


DIURNAL: HOURLY VALUES
Hour: 0 2 4 6 8 10 12 14 16 18 20 22 24
TEMPERATURE.
°C
25
20
HUMIDITY.
%
90
80
70
60
50
40
PRESSURE.
MILLIBARS.
+2
+1
0
-1
-2
WIND SPEED
METRES/SEC.
6
5
4
3
2
RAINFALL.
INCHES.
·02
·01
0
ANNUAL: MONTHLY MEANS
J F M A M J J A S O N D
30
25
20
90
80
70
60
50
40
+4
+3
+2
+1
0
-1
-2
-3
-4
ZAN: + 1010·7 mb
TAB: + 874·1 mb
KAM: + 868·7 mb
7
6
5
4
3
2
10
5
0

heat, and to the fact that some of the radiation penetrates to considerable depths. The water acts as a steadying influence by giving the sea breezes during the day and the land breezes at night. Inland, this steadying factor is not present; the amount of water vapour in the air is less, and there is no source of cool breezes. Thus, during the day, the day, the ground is strongly heated and at night is cooled down by radiation, giving a large diurnal range. During the wet season this effect is not present, and both mean temperature and daily range are below the average.

Humidity.—The humidity is, of course, closely allied to the temperature, and at first the humidity curves appear to be practically the reverse of those of temperature. During the day, as the air gets warmer, its "capacity" for water vapour increases, and unless the amount of water vapour in the air is increased, the relative humidity falls. This is what happens over the inland plateau, as exemplified by Tabora, and the curve of absolute humidity or of vapour pressure would therefore be a straight line. Where there is a large body of water, however, a certain amount evaporates, the absolute humidity increases and the relative humidity does not fall so low. During the wet season at Tabora, somewhat similar conditions apply, and we have in March a mean humidity of 76 per cent, with a daily range between 93 per cent and 58 per cent, while in September the mean humidity is only 43 per cent, with the range between 85 per cent and 31 per cent.

Pressure.—It will be seen that the diurnal range of pressure is almost identical at the three stations—4 millibars (0.12 inches)—the slight difference in phase being due to the differences between the local mean time and standard time. This diurnal range in the case of Kampala and Tabora is greater than, and in the case of Zanzibar is half, the annual range of the mean monthly values. It is interesting to compare this with conditions in higher latitudes; for example, the mean diurnal range at Aberdeen is 0.7 millibars (0.02 inches), while the annual range of mean monthly pressures is 8 millibars.

It may be worth noting in passing that the barometric pressure over the greater part of East Africa is between 25 and 26 inches.

Wind Speed.—The average wind speed is of the same order at the three stations. The diurnal variation is of normal type at Zanzibar; at Tabora there is a sharp rise after sunrise followed by a fall before noon, and at Kampala consists of a rise during the afternoon, probably a breeze from the lake. The annual curve shows very little variation at Kampala, while at Zanzibar the wind is strongest when the sun is north—that is, during the south-east trade regime. At Tabora, the winds fall off during the rainy season when the strongest convection conditions obtain and the area is not swept by any definite wind current. During the dry season a south-easterly wind blows steadily.

Rainfall.—It will be seen that at Zanzibar the heaviest rain occurs in April and May, when the sun has passed north and the south-east trades have started. Also the rain tends to fall in the morning, before the temperature has reached its maximum. At Tabora the wettest months are December to March, and the rain generally falls after midday, when convection conditions are strongest. At Kampala there is no really dry spell, but maxima occur during the months when the sun is overhead; rain seldom falls there in the evening.

A Short Account of the work of the Kilimanjaro Native Co-operative Union, Ltd.

By A. L. W. BENNETT, *Manager of the Union.*

The Kilimanjaro Native Co-operative Union, Ltd., with its headquarters in Moshi, Tanganyika, is the largest co-operative organization of natives in Africa. It took over, in 1932, the former Kilimanjaro Native Planters' Association, which was formed in 1922 by the native coffee growers on Kilimanjaro to assist them to market their coffee. The original association was not a corporate body, and there were many difficulties in its life. The chief of these was to obtain adequate representation of its members, and in actual fact the association was run by a handful of progressive growers, and the rank and file knew very little of its policy. At any general meeting not more than 5 per cent of the members were present, or had a voice in its management. Nevertheless, the need for some sort of organized marketing of their crops kept the members together.

As soon as the Tanganyika Co-operative Societies Ordinance of 1932 was enacted, the K.N.C.U. was formed to carry out reorganization. The new form of organization brought into being a number of primary societies, and each of these became affiliated to the Union. The membership of a society consisted of farmers living in a sub-chieftainship; but in some cases two or more societies were formed in such an area, owing either to its extent, or to the large number of farmers, or their differing needs. At the present time there are 27 primary societies affiliated to the Union, with a total membership of 18,554.

The Union acts as the medium for organizing the societies, and propaganda is undertaken to impress the value of co-operative effort. When a body of growers show interest and a desire to form a society an open meeting is arranged in that area, and those present elect amongst themselves a committee, consisting usually of twelve members, two of whom are chosen as chairman and vice-chairman of the new society. Their members undertake to pool their crops and to send them to the Union for marketing, and the by-laws laid down by the Union must be adopted. The new society then builds and equips a store and office, with the assistance of the Union, which advances material, and engages from amongst its members a clerk and one or more farm supervisors. The duties of the former are to weigh produce brought in by members, to issue receipts for it, to give payments on account against the delivery of the produce, and to make the final payments when the produce has been sold by the Union. He is responsible for all book-keeping and cash transactions. Some of these clerks handle and distribute as much as £5,000 in a season. The farm supervisor is responsible for giving demonstrations and advice to farmers, and for supervising the grading of produce. He has to keep a register of all members, showing each year the number of coffee trees both over and under three years old. He also keeps the stock of spraying apparatus and materials, and has to organize the annual campaign against Antestia and Thrips. Both of these paid officials work under the supervision of the chairman and his committee, who work in an honorary capacity.

Some societies stock articles for sale to members, and at present this is mostly confined to agricultural implements and

materials. When a society is able to estimate the quantity of a certain crop available amongst its members, this is reported to the Union, which informs the society of the ruling market price and of the rate at which advance payments can be made to members on delivery of the produce. When a sufficient quantity is brought in to the society, arrangements are made with the Union for its transport to either the Union's stores or to railhead, and from then onwards the Union takes charge, and is responsible for the sale of the produce and for remitting to the society the balance of the sale proceeds. These balances are distributed by the society amongst its members according to the quantity of produce entered on the member's receipt, which is taken from him and destroyed. Duplicates of all receipts are sent to the Union almost daily for record and checking.

Besides the work of collecting and bulking produce, many societies undertake the upkeep of roads and bridges, assist with the schooling of the children, and generally enter into the social life of the community. The value of this social side of the work of co-operative societies cannot be exaggerated.

Committee meetings of a society are held as frequently as is found necessary, generally once a month, and as each committee man is chosen from a subdivision of the area all shades of opinion are represented. Annual general meetings are held, and it is usual for about 75 per cent of the members to attend.

The membership of the Union is comprised of the societies affiliated to it, the present number being 27. The chairman of each society represents his society on the Union, and has one vote at a general meeting of the Union. The vice-chairman of a society is also allowed to attend such general meetings, so that the chairman can consult with him before giving a decision on any point, and as a witness of the behaviour of the chairman when he reports to his society. From the chairmen are elected annually the officers of the Union, consisting of a president, a vice-president and five members of the committee of the Union. Election is carried out by ballot, and, to ensure representation from every society, the societies are divided into three groups, and two committee men for the Union are elected from each of two of the groups, and one only is elected from the remaining group, which has only a small annual production.

The Union has a staff of five clerks, a secretary-treasurer, and a European supervising manager. The main duties of the Union are to supervise and assist the work of the affiliated societies, to provide storage accommodation for produce, to market the produce, and to arrange crop finance. It will be shown below how these duties are undertaken.

The instruction of the clerks of societies is done by the Union, which keeps a continuous check on their work by a system of returns. If difficulties arise, a supervising clerk is sent from the Union to the society, and he remains there until matters are put right. The Union can suspend an official of a society, or any society, should irregularities occur. A copy of the minutes of every meeting of a society must be sent to the Union, so that they can be scrutinized, to ensure that the society is working on sound co-operative principles. When necessary, officials of the Union tour the societies and address meetings to explain the work which is being accomplished, and to keep the societies *au fait* with the methods of marketing adopted.

The Union owns three godowns in Moshi, where produce from societies can be accommodated until there is a sufficient quantity to make a good parcel for marketing. An endeavour is made to find

outlets for produce before its delivery to the Union, but in many cases (particularly with coffee) this is not possible, and the produce is then sent on consignment to agents who have the ability to dispose of the produce in the best markets.

As regards crop finance, it is sometimes thought that co-operative bodies should divorce the business of finance from that of marketing. When it is possible to do so, it is undoubtedly a sound policy, and the Union has adopted this method on occasion. But when markets are uncertain and the quick sale of produce is difficult, it is found that financing institutions are not anxious to undertake the finance of a crop unless it is left in their hands for disposal. Coffee is the most important crop, both as regards quantity and value, and it has been found that the best way to finance it is by arranging with those merchants who are handling the sale to establish a revolving letter of credit with a local bank for a sum which will allow the Union to pay to growers an advance against delivery of their coffee of about two-thirds of the estimated net value. Documents, such as waybills, bills of lading, etc., are deposited as security against repayment of the credit when sales have been effected.

The funds of the Union are derived from three main sources—from the usual trade commission which is charged for all sales; from fractions of a cent which it is impossible to distribute to individual members; and, in the case of coffee only, from a levy which is made on all coffee brought in by members. The fractions of a cent are caused through all payments being on a pound weight basis, so that should the total proceeds of a sale work out at so many cents and a fraction per pound of the produce, then the fraction cannot be distributed, and the total of these fractions goes into the general funds, known as Accumulated Funds. The main object of the levy on coffee is

Coffee receiving final picking over, at a primary Society, before despatch to the K.N.C.U.

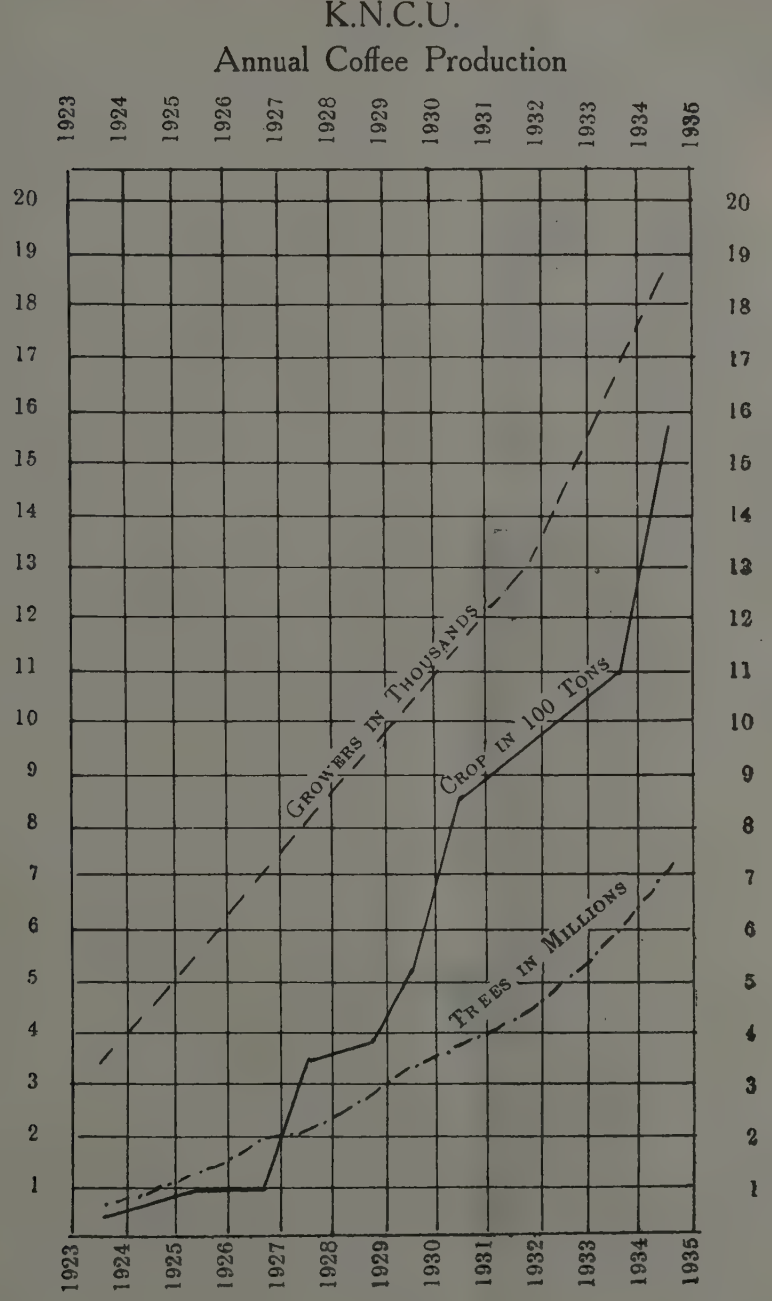
to produce sufficient funds for the effective sanitation of the coffee trees by supplying pumps and materials for combating Antestia and Thrips.

No bonuses or dividends are paid to members, as, with the exception of the coffee levy, the full net proceeds of sales are distributed, and the Accumulated Funds of the Union are utilized for the running expenses and for capital development. At the end of each year an honorarium is usually voted to the unsalaried officials and committee men of the Union and the societies; these 378 people get about Sh. 3,500 distributed amongst them.

During the 1934-35 harvests (July to June), the following quantities of produce were handled: 1,584 tons of parchment coffee; 323 tons of maize and maize-flour; 14 tons of beans; 29 tons of wheat; 79 tons of onions; 16 tons of garlic; 69 tons of eleusine; 18 tons of *buni* coffee; and 23 tons of shade-dried cattle hides. The Union also purchased and distributed to societies improved seed of coffee and wheat.

It is interesting to compare the annual tonnage of parchment coffee handled by the Union since its formation, together with the net proceeds paid to the growers (bags, transport, handling, and all other

Shade-drying hides in a special building of a primary Society.


K.N.C.U.
Annual Coffee Production
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Growers in Thousands
Crop in 100 Tons
Trees in Millions

charges, including levy and commissions, having been deducted). It will be seen that the crop has increased annually, but prices have steadily declined.

	Tons.	*Paid to Growers.* £	*Cents per lb.*
1932-3 ...	1,070 ...	35,426 ...	29
1933-4 ...	1,165 ...	35,230 ...	27
1934-5 ...	1,584 ...	35,481 ...	20

The 1934-35 crop was harvested from approximately 5 million coffee trees over 3 years old, which averages nearly ¾ lb. of parchment per tree, or 2¾ cwt. of clean coffee per acre. The estimated crop for the 1935-36 season is 2,000 tons of parchment coffee, as a number of young trees will be coming into bearing. The total number of trees under 3 years old is approximately 2¼ million.

No co-operative credit societies (such as exist extensively in India and the East) have been formed, and it is considered unwise to bring this form of co-operation into being for some considerable time. Although co-operative marketing is the main work of the Union and its societies, the broad form of co-operative effort is also encouraged, and the primary societies are chiefly responsible for creating a public opinion with regard to such matters as good farming methods and crop sanitation. The Union publishes a monthly bulletin in the vernacular, of which 1,000 copies are distributed, dealing with matters of interest to the members, and this is found to be a valuable medium for propagating the spirit of co-operation, and a useful platform for the ventilation of opinion.

Co-operative societies have their own particular difficulties, and the most dangerous is probably provided by those people who are anxious to accept office for the sole purpose of self-advancement.

A successful co-operative marketing organization depends on a recognized need for such an organization, an informed and loyal membership, a sound financing and marketing policy, and an honest and efficient management.

Reviews

A TEXT BOOK OF WEST AFRICAN AGRICULTURE, SOILS AND CROPS, *by* F. R. Irvine, D.Sc., F.L.S., Senior Science Master, Achimota College. Oxford University Press, 1934; 7s. 6d. net.

This text-book is intended "primarily for Africans, as an aid to students taking Agricultural Science as a subject in the Cambridge School Certificate Examination" and for West African secondary schools and advanced teaching generally. The main objects in view are "to stimulate an interest in agriculture, to follow up practical work in school gardens, farms and agricultural camps, and to lead students to study . . . scientific agriculture." Live stock and poultry are not dealt with.

Following general chapters on matters concerning the soil and its amelioration, the West African crop-plants, comprising a wide range of food, fruit and export crops, are individually described and their management discussed. Finally, a further series of general chapters deals with propagation, the nature and treatment of pests and diseases, and methods of teaching by means of school gardens.

The subject-matter is conveniently arranged, full of facts and explanations without being dull, and achieves a high standard of accuracy and insight. The book is commendably free from counsels of perfection, the besetting sin of agricultural instruction to natives.

The allusions and illustrations are, of course, West African, but the crops dealt with are, with few exceptions, common to both east and west. There are naturally differences of emphasis, and agriculture at the higher altitudes is not dealt with. While for these reasons the book in many respects does not fit East African conditions, it can be confidently recommended to teachers on this side of the continent as containing a great deal of matter of common interest not otherwise available in convenient form.

W.N.

PYRETHRUM FLOWERS, *by* C. B. Gnadinger. 269 pp. and 39 illustrations. McLaughlin Gormley King Co., Minneapolis, U.S.A.

The author of this book has produced a very comprehensive survey of all the information on pyrethrum that was available up to September, 1933.

Apart from the chapters on the toxic principles of pyrethrum and their estimation, the book is written in a style which should appeal to the non-scientific reader as much as to the scientific, and should prove of value both to growers and users of this insecticide.

After a brief outline of the history of pyrethrum, the author deals with its commercial sources, and it is of interest to note that in Middle Japan four-year-old plants produce 200 to 300 flowers each, and 744 lb. per acre, the actual cost of production to the farmer being about sixpence a lb. In 1931 the U.S.A. bought four and a half million lb. from Japan, at an average price of sixpence a lb., which shows no profit to the producer. In Northern Japan, whence the bulk of the flowers come, the cost of production was about fivepence, showing a profit of a penny a lb.

The generally accepted idea that Dalmatian pyrethrum is better than Japanese is disposed of, the average of a large number of determinations giving 0.82 per cent and 1.0 per cent pyrethrins respectively. An interesting value of 1.44 per cent is quoted for Kenya flowers.

In discussing the best time for harvesting the flowers, it is pointed out that the

yield of pyrethrins can be quadrupled by merely allowing the flowers to mature. On the other hand, plants grown in absence of sunlight give a pyrethrin content reduced by half or more.

Several technical chapters deal with the isolation, structure and evaluation of the toxic principles. The general conclusions on the question of correlation of the chemical and biological methods of evalution are that toxicity is more or less proportional to the total pyrethrin content.

On the question of storage of pyrethrum, it is pointed out that although whole flowers lose activity less rapidly than ground ones, in the course of several months a definite loss occurs.

The manufacture and use of pyrethrum extracts, sprays, dusts, etc., is given in five useful and interesting chapters, and the book concludes with a most comprehensive list of 604 references to the available bibliography.

The work can be confidently recommended to all farmers, users and workers in the pyrethrum industry.

R.R.W.

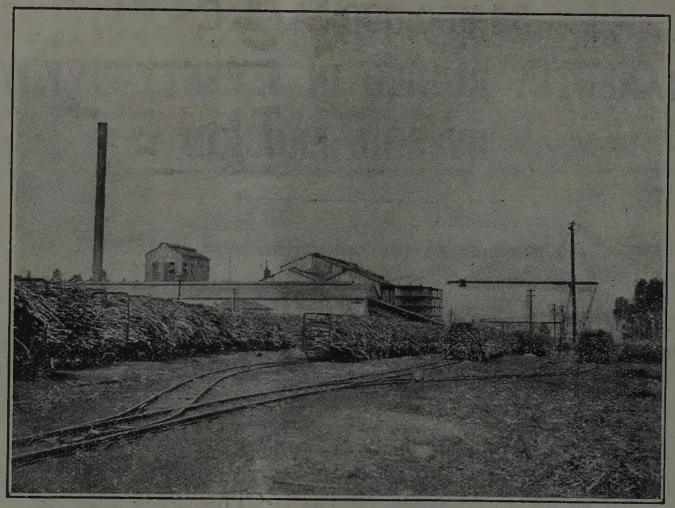
35,000,000 ACRES PERMANENTLY RUINED IN SEVENTY-FIVE YEARS BY SOIL EROSION

10 per cent of the cultivated land in U.S.A.

Soil Erosion every year robs U.S.A. fields of twenty times as much plant food as has been consumed by crops grown

These figures are published by the United States Departments of Agriculture and Interior Soil Erosion Service, and they warrant the serious consideration of the East African farming community. The purpose of these notes is to direct attention to the modern methods being adopted to combat this evil. That the loss of soil in East Africa, due to climatic conditions and the habits of native pastoralists, is a gradual process, tends to obscure the fact that this loss is yearly attaining more serious proportions. Recognition of this fact is shown by the issue by the Kenya Department of Agriculture of a booklet on the subject, and by the staging of some very excellent and realistic exhibits, showing the effects of soil erosion, at the show recently held in Nairobi under the auspices of the Royal Agricultural and Horticultural Society of Kenya.

The Caterpillar Tractor Company, in its booklet entitled *Crops or Canyons*, deals with the methods now being adopted to minimise losses due to soil erosion. This booklet is profusely illustrated with photographs and diagrams, and is, of course, prepared with the object of increasing the sales of their tractors, graders and terracers, which aroused so much interest when shown by Gailey and Roberts, Ltd., at the recent show. It is different from the usual trade booklet, in that it contains a tremendous amount of useful information and advice regarding a subject of vital importance to our agricultural communities. Gailey and Roberts, Ltd., who are agents for the Caterpillar Tractor Company, will be pleased to send a copy of *Crops or Canyons* to anyone interested, and also to demonstrate the Caterpillar equipment at their showrooms in Sadler Street, Nairobi.



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